US009097622B2

(12) **United States Patent**
Gotch

(10) **Patent No.: US 9,097,622 B2**
(45) **Date of Patent: Aug. 4, 2015**

(54) **PROCESS INTERFACE VALVE ASSEMBLY**

(75) Inventor: **James E. Gotch**, Kirtland, OH (US)

(73) Assignee: **Swagelok Company**, Solon, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 292 days.

(21) Appl. No.: **13/640,149**

(22) PCT Filed: **Apr. 15, 2011**

(86) PCT No.: **PCT/US2011/032638**
§ 371 (c)(1),
(2), (4) Date: **Oct. 9, 2012**

(87) PCT Pub. No.: **WO2011/130601**
PCT Pub. Date: **Oct. 20, 2011**

(65) **Prior Publication Data**

US 2013/0025725 A1 Jan. 31, 2013

Related U.S. Application Data

(60) Provisional application No. 61/324,516, filed on Apr. 15, 2010.

(51) **Int. Cl.**
F16K 11/22 (2006.01)
G01N 1/20 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G01N 1/2035*** (2013.01); ***F16K 11/20*** (2013.01); ***F16K 27/065*** (2013.01); ***F16K 35/14*** (2013.01); *F16K 11/22* (2013.01); *G01N 2001/205* (2013.01)

(58) **Field of Classification Search**
CPC F16K 11/22
USPC 137/637, 637.1, 613; 73/863.85, 863.86
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,944,456 A * 1/1934 Pearson 137/271
3,303,866 A * 2/1967 Ray 431/54
(Continued)

FOREIGN PATENT DOCUMENTS

CN 201166178 12/2008
GB 1333499 10/1973

OTHER PUBLICATIONS

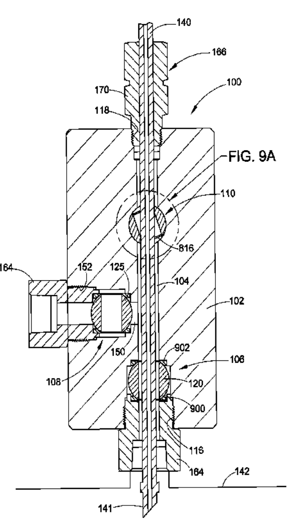
International Search Report and Written Opinion from PCT/US11/32638 dated Jun. 30, 2011.
(Continued)

Primary Examiner — John K Fristoe, Jr.
Assistant Examiner — Christopher Ballman
(74) *Attorney, Agent, or Firm* — Calfee, Halter & Griswold LLP

(57) **ABSTRACT**

A valve assembly includes a valve body having a fluid access passage extending from a process fluid port to an access port, a block valve disposed in the fluid access passage and movable between open and closed conditions, an access blocking device disposed in the fluid access passage between the access port and the block valve, and a valve interlock arrangement. The access blocking device is movable from an access blocking condition in which access to the block valve through the access port is blocked, to an access permitting condition in which access to the block valve through the access port is permitted. The valve interlock arrangement is configured such that the block valve is prevented from being moved to the closed condition when the access blocking device is in the access permitting condition.

23 Claims, 26 Drawing Sheets



(51) **Int. Cl.**

F16K 27/06	(2006.01)
F16K 35/14	(2006.01)
F16K 11/20	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,691,846	A		9/1972	Ingold
3,792,612	A	*	2/1974	Lammel et al. 73/864.34
4,108,174	A		8/1978	Slivenko
4,246,115	A		1/1981	Swank
4,294,124	A	*	10/1981	Kalwaitis 73/863.85
4,429,711	A	*	2/1984	Schomer 137/385
4,841,787	A	*	6/1989	Waterman 73/866.5
4,890,643	A	*	1/1990	Oliver 137/614.11
5,410,920	A	*	5/1995	Westwick 73/866.5
5,413,309	A		5/1995	Giesler
5,425,305	A		6/1995	Mauritz
5,704,398	A		1/1998	Baker
5,770,809	A		6/1998	Waterman
5,931,801	A		8/1999	Burbank et al.
6,220,290	B1		4/2001	Lomax
6,620,124	B1		9/2003	Peavey
6,964,517	B2		11/2005	Welker
2005/0132825	A1		6/2005	Talutis
2007/0123825	A1		5/2007	King et al.
2010/0063482	A1		3/2010	Mansour et al.

OTHER PUBLICATIONS

Swagelok Double Block and Bleed Valve—with interlocking handle cam discs preventing simultaneous open position for both valves, concept drawing and isometric views (3 pgs) presented by Swagelok Company to potential customer in discussion of potential sale, prior to Apr. 15, 2009.

* cited by examiner

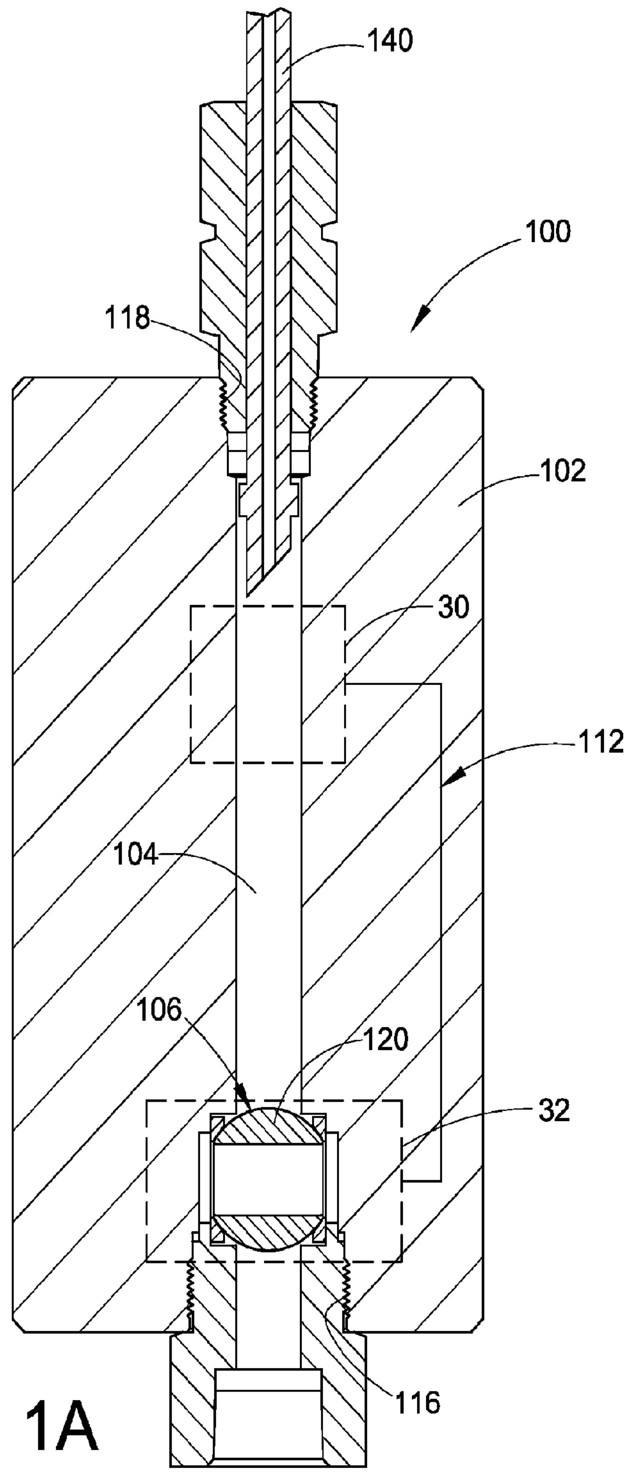


FIG. 1A

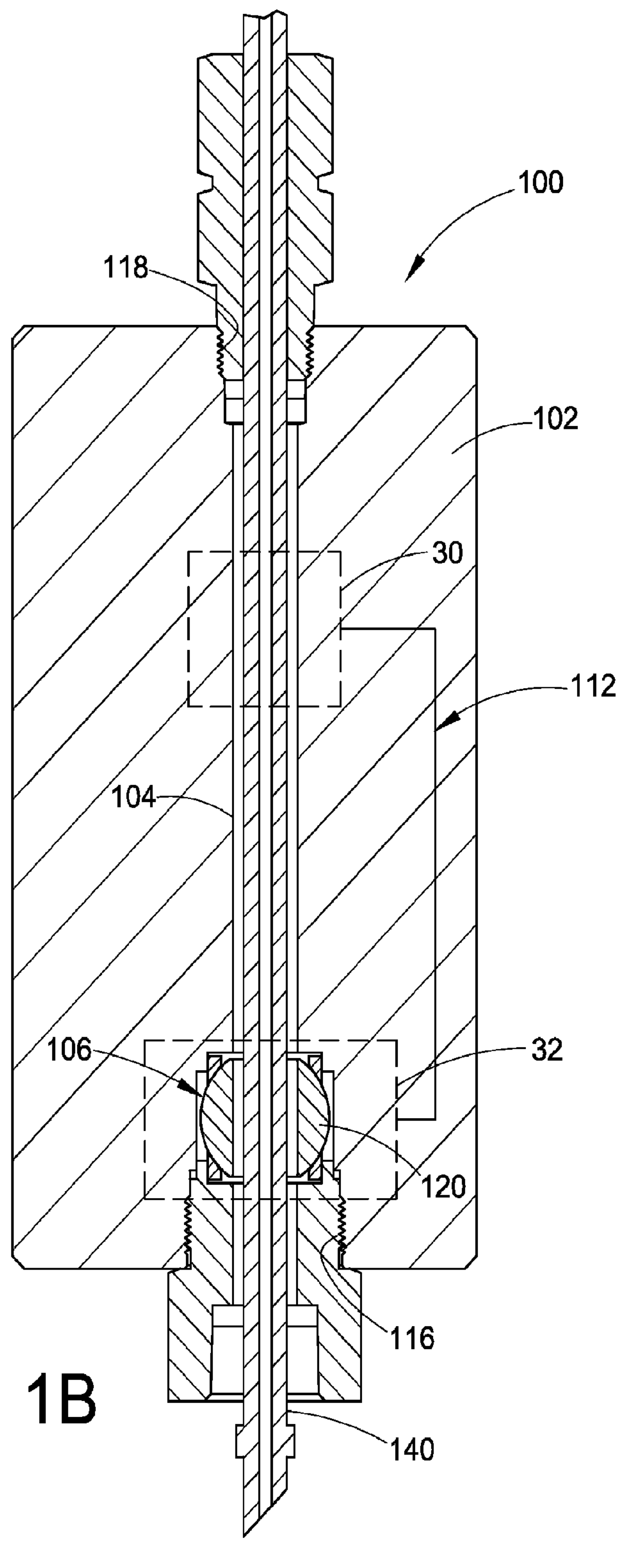
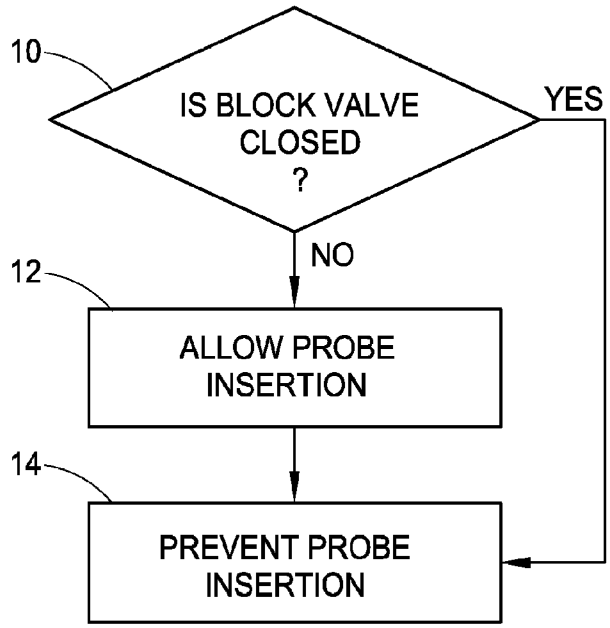
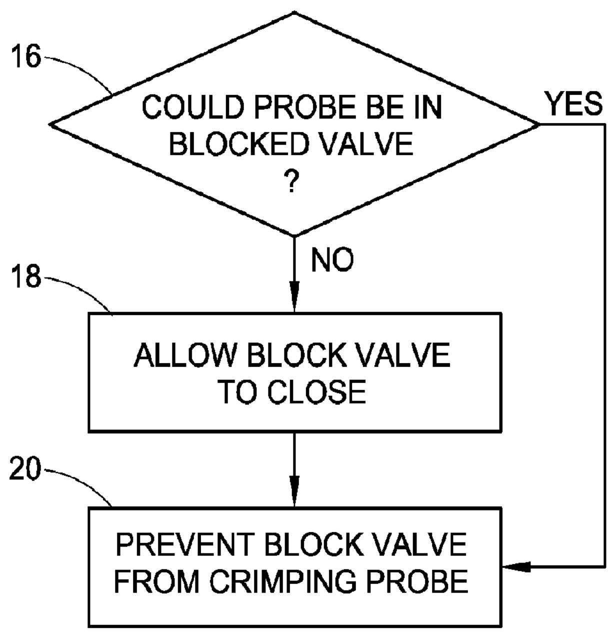


FIG. 1B



10
IS BLOCK VALVE CLOSED ?
YES
NO
12
ALLOW PROBE INSERTION
14
PREVENT PROBE INSERTION

FIG. 2



16
COULD PROBE BE IN BLOCKED VALVE ?
YES
NO
18
ALLOW BLOCK VALVE TO CLOSE
20
PREVENT BLOCK VALVE FROM CRIMPING PROBE

FIG. 3

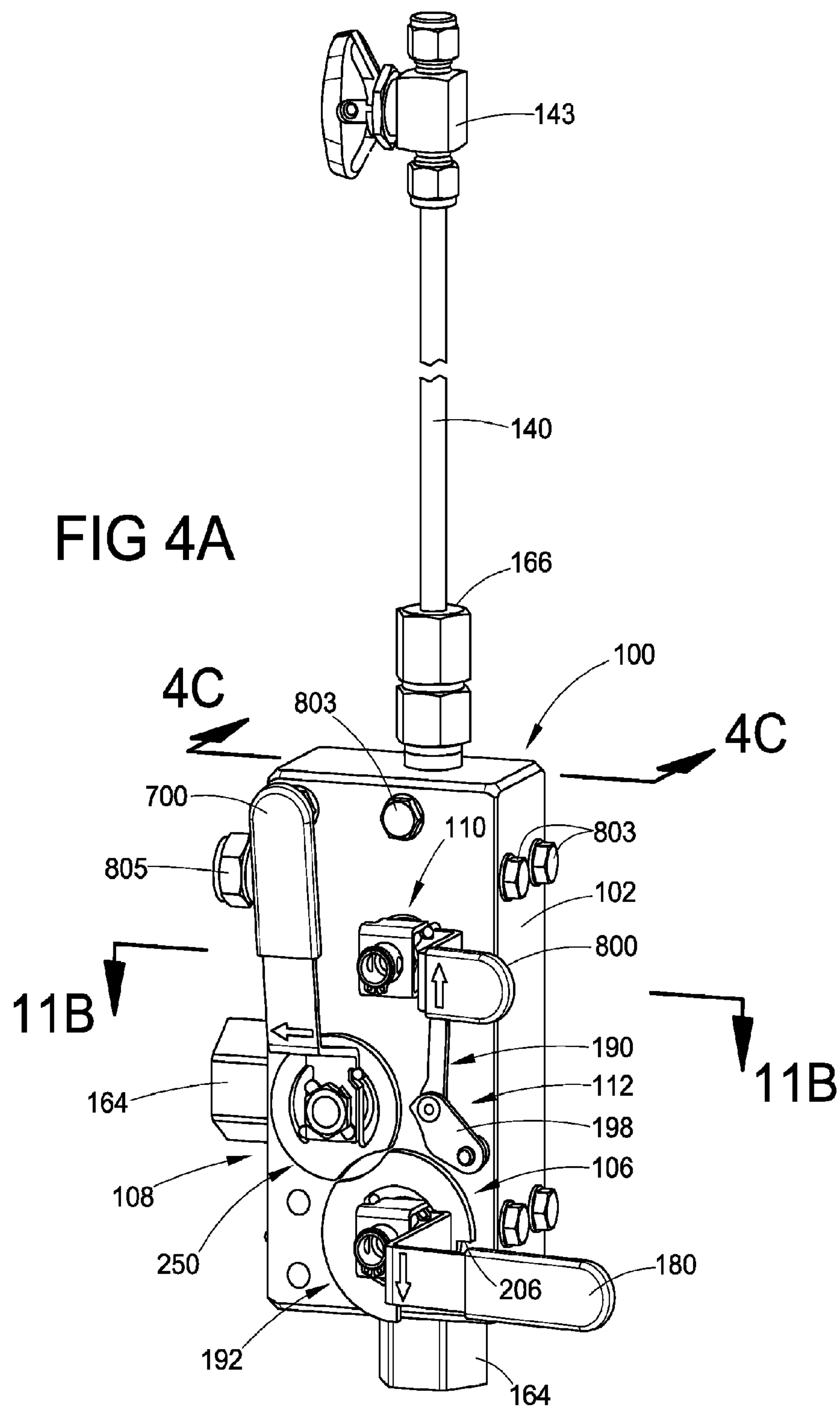

143
140
166
100
4C
803
4C
700
110
803
805
102
800
11B
11B
190
164
112
198
108
106
250
180
206
192
164

FIG 4A

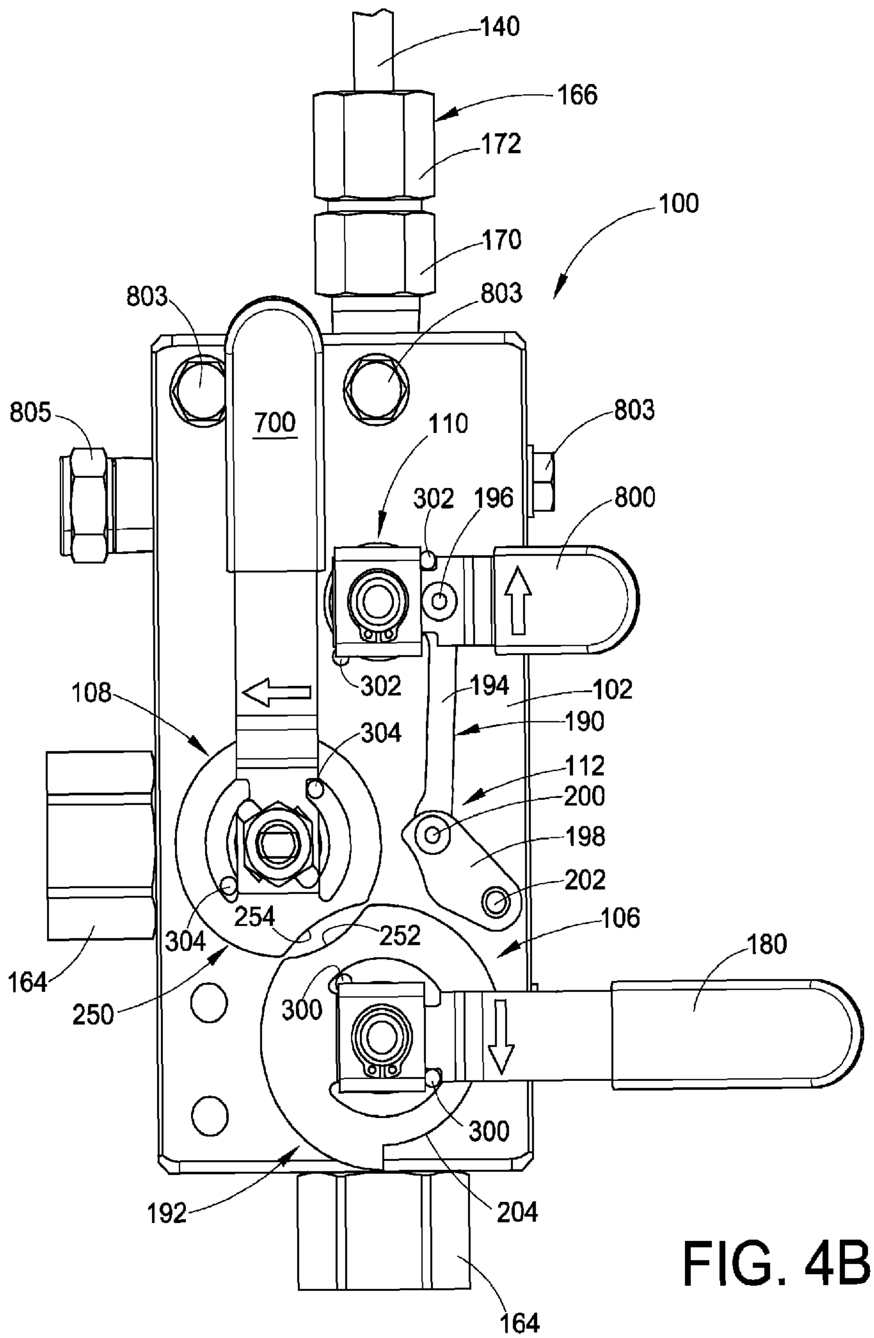

140
166
172
170
100
803
803
805
700
110
803
302
196
800
302
194
102
108
190
304
112
200
198
202
304
254
252
106
180
164
250
300
300
192
204
164

FIG. 4B

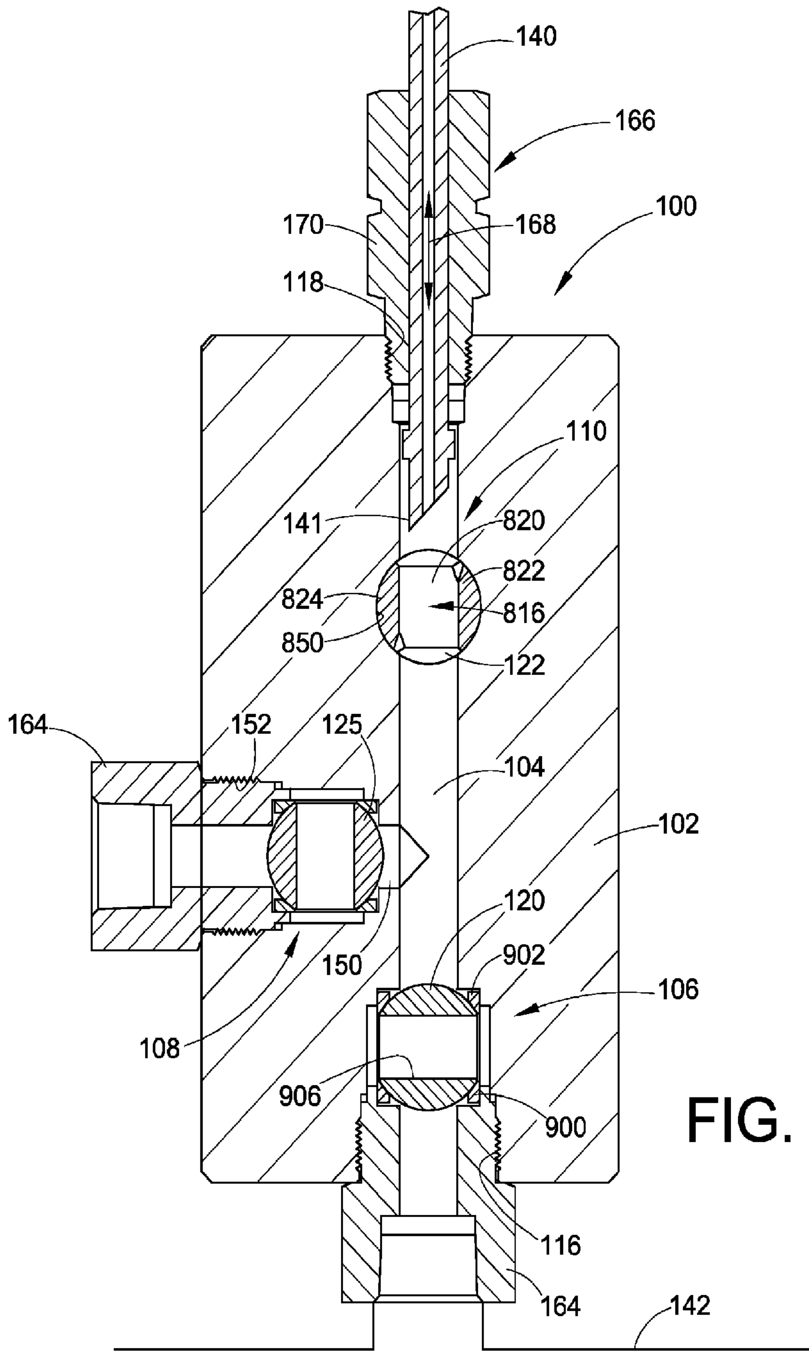

140
166
100
170
168
118
110
141
820
822
824
816
850
122
164
152
125
104
102
120
150
902
106
108
906
900
116
164
142

FIG. 4C

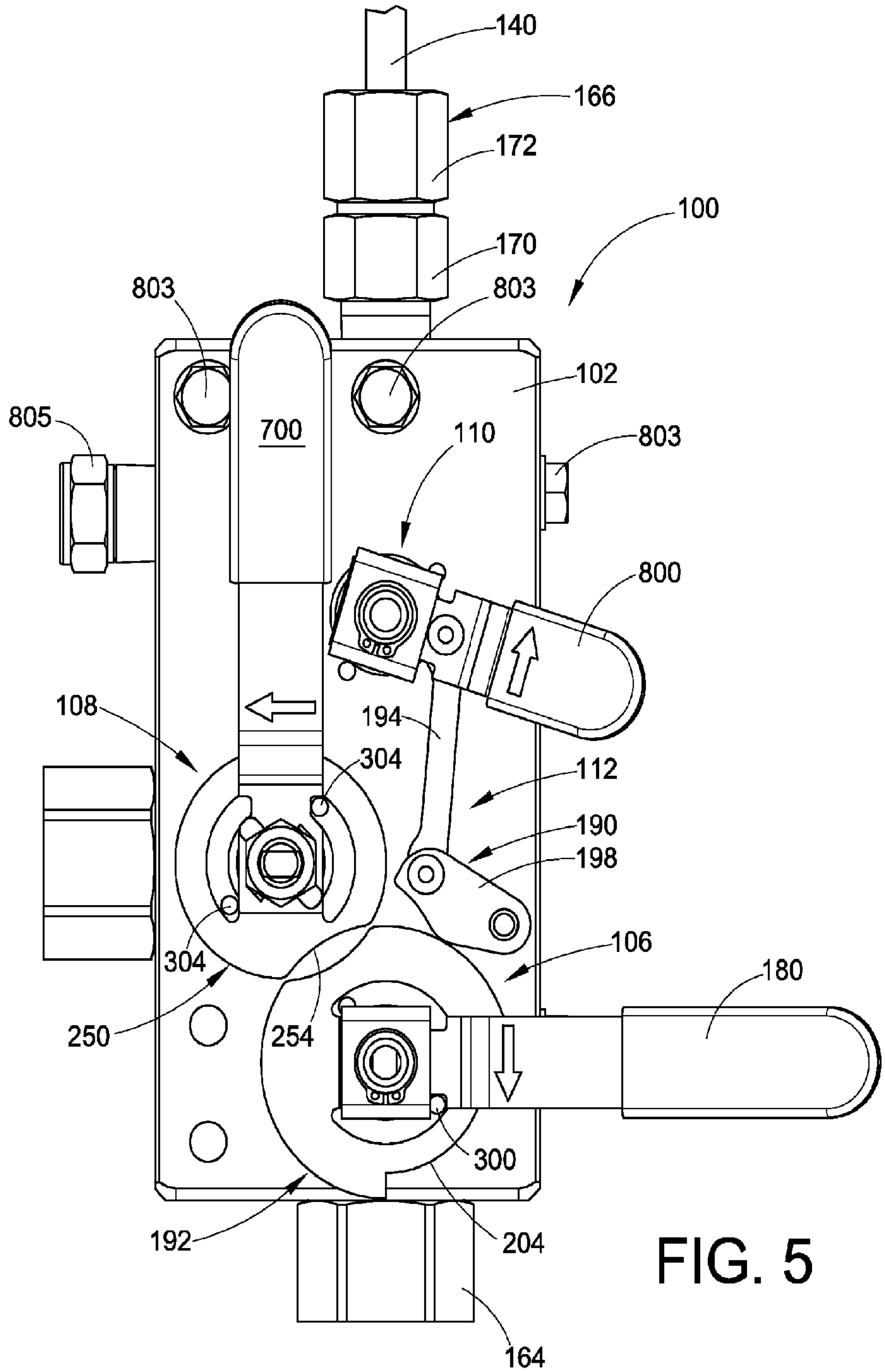

140
166
172
170
100
803
803
102
805
700
110
803
800
194
108
304
112
190
198
304
106
180
250
254
300
192
204
164

FIG. 5

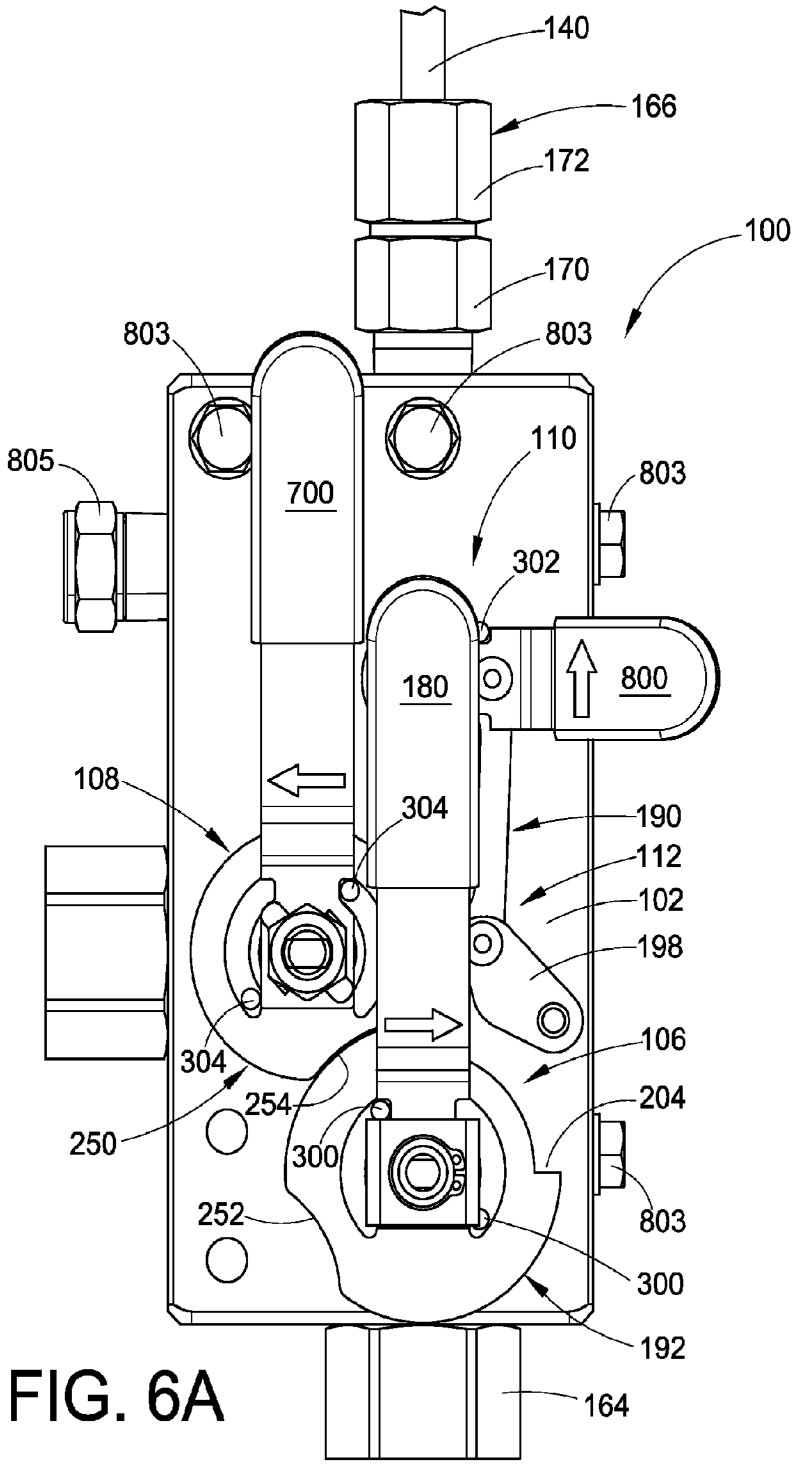

140
166
172
100
170
803
803
805
110
700
803
302
180
800
108
304
190
112
102
198
106
304
250
254
204
300
252
803
300
192
164

FIG. 6A

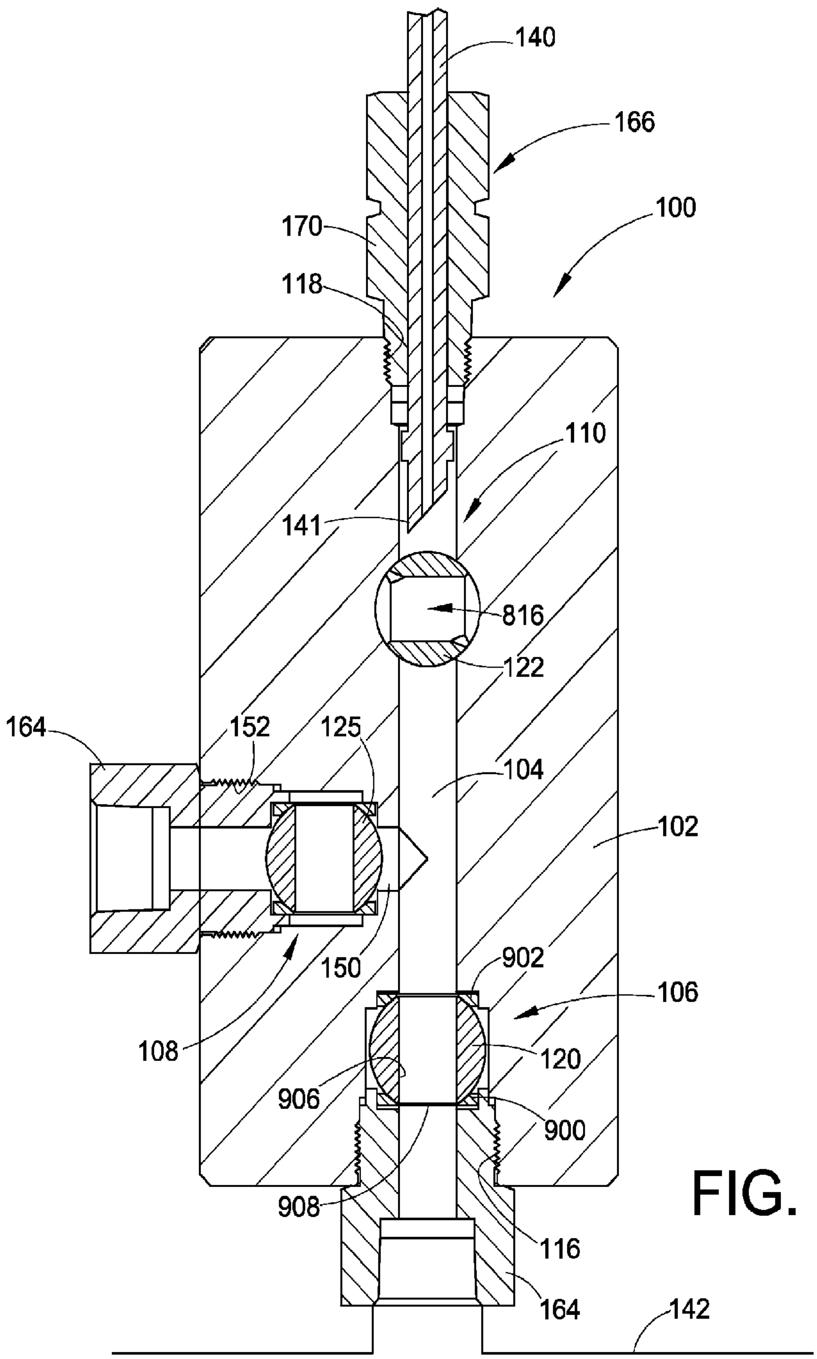

140
166
100
170
118
110
141
816
122
164
152
125
104
102
150
902
106
108
120
906
900
908
116
164
142

FIG. 6B

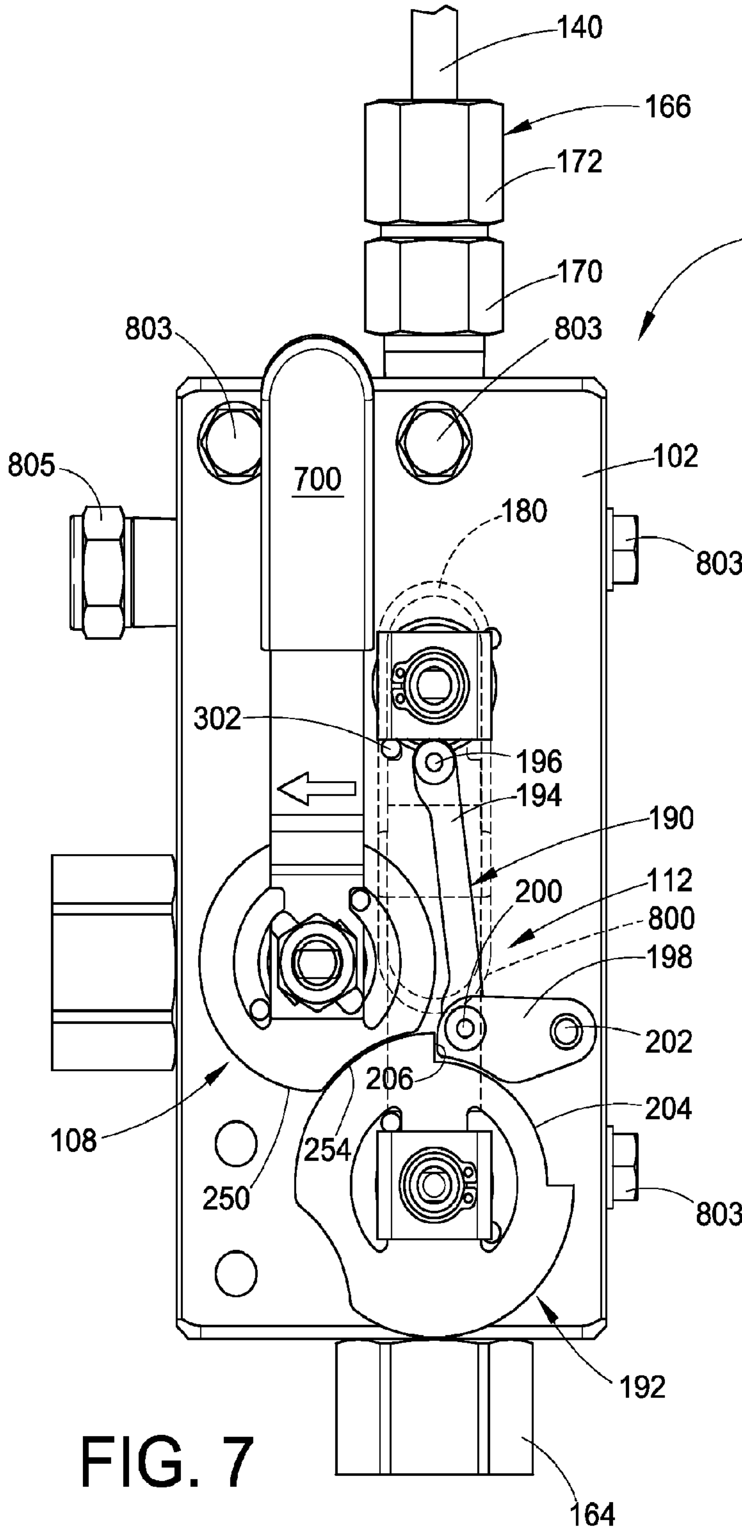

140
166
172
100
170
803
803
805
700
102
180
803
302
196
194
190
200
112
800
198
202
206
204
108
254
250
803
192
164

FIG. 7

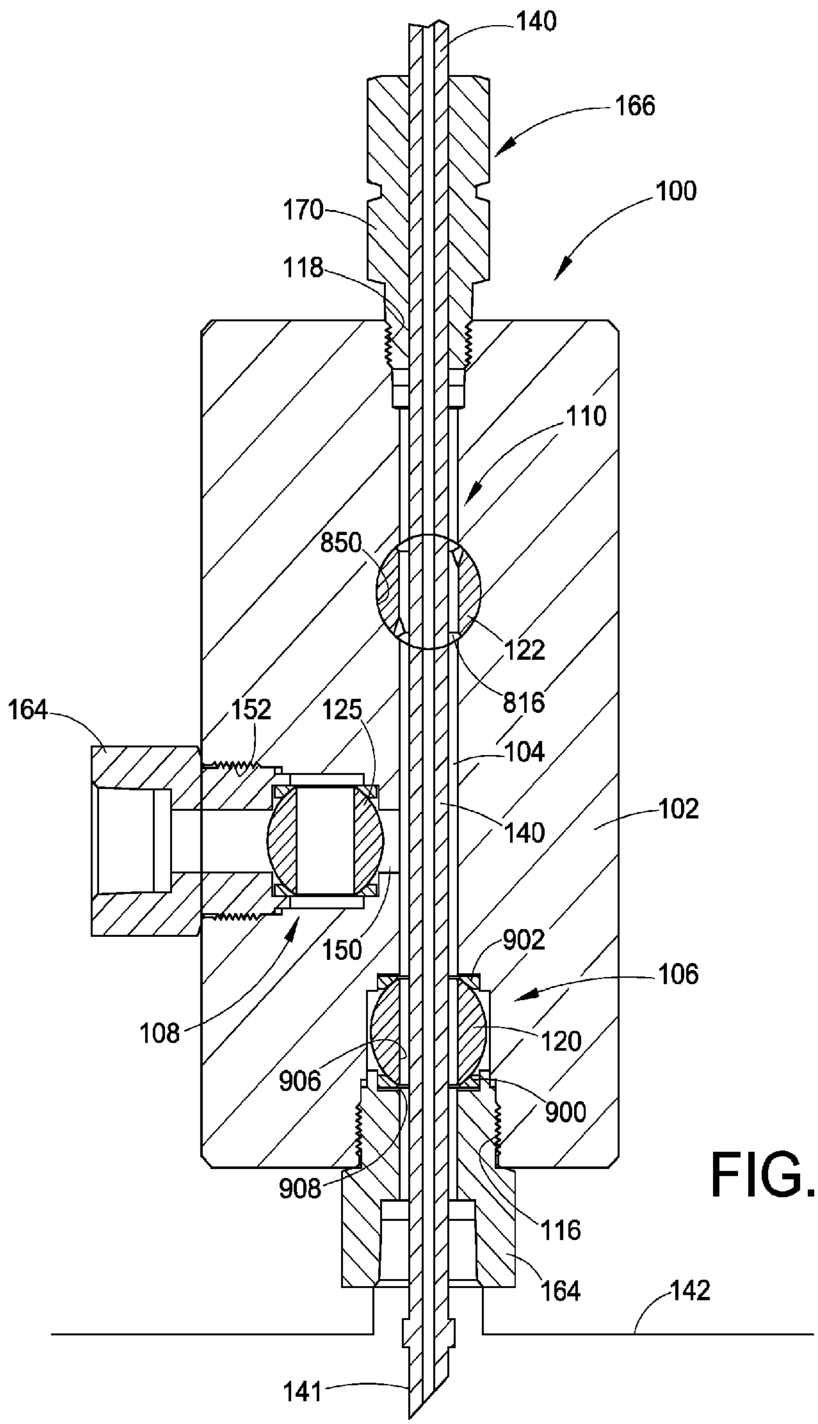

140
166
100
170
118
110
850
122
816
164
152
125
104
140
102
150
902
106
108
120
906
900
908
116
164
142
141

FIG. 8

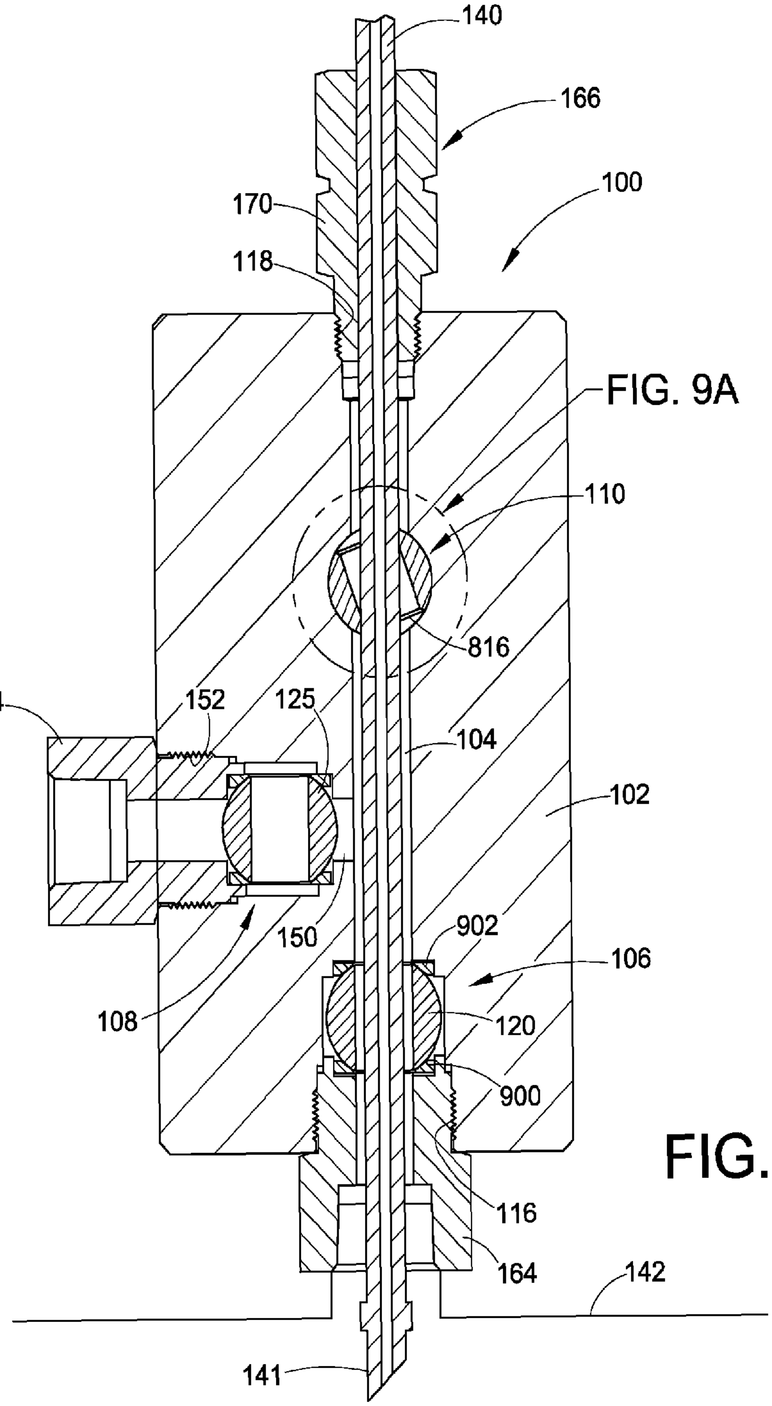

140
166
100
170
118
FIG. 9A
110
816
164
152
125
104
102
150
902
106
108
120
900
116
164
142
141

FIG. 9

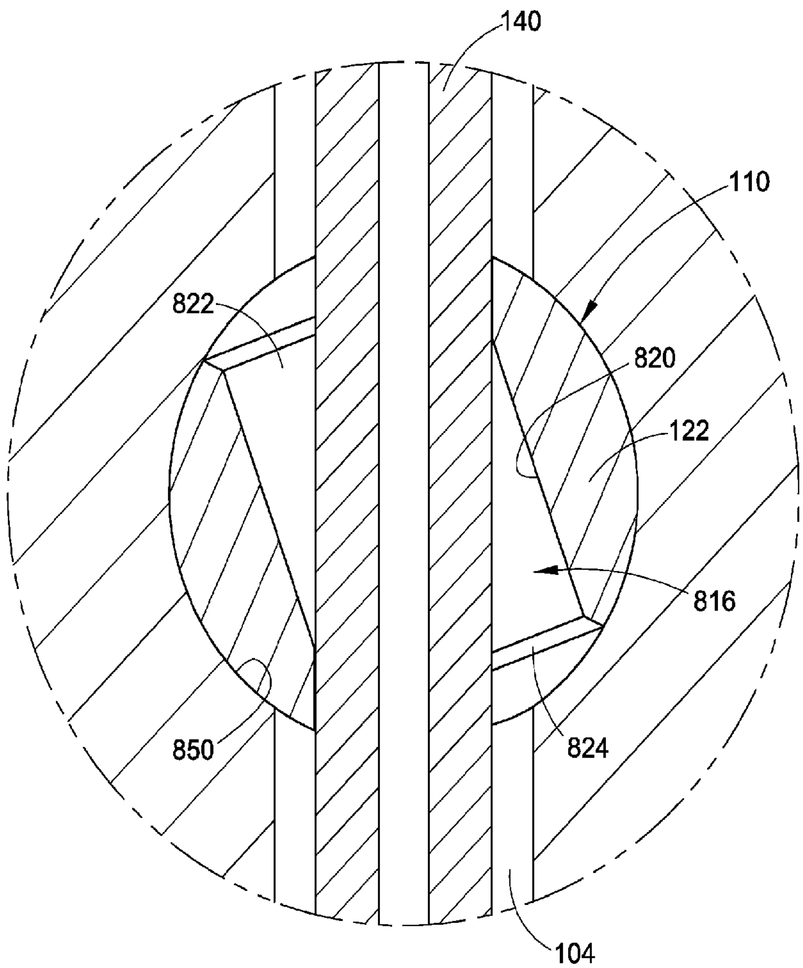


FIG. 9A

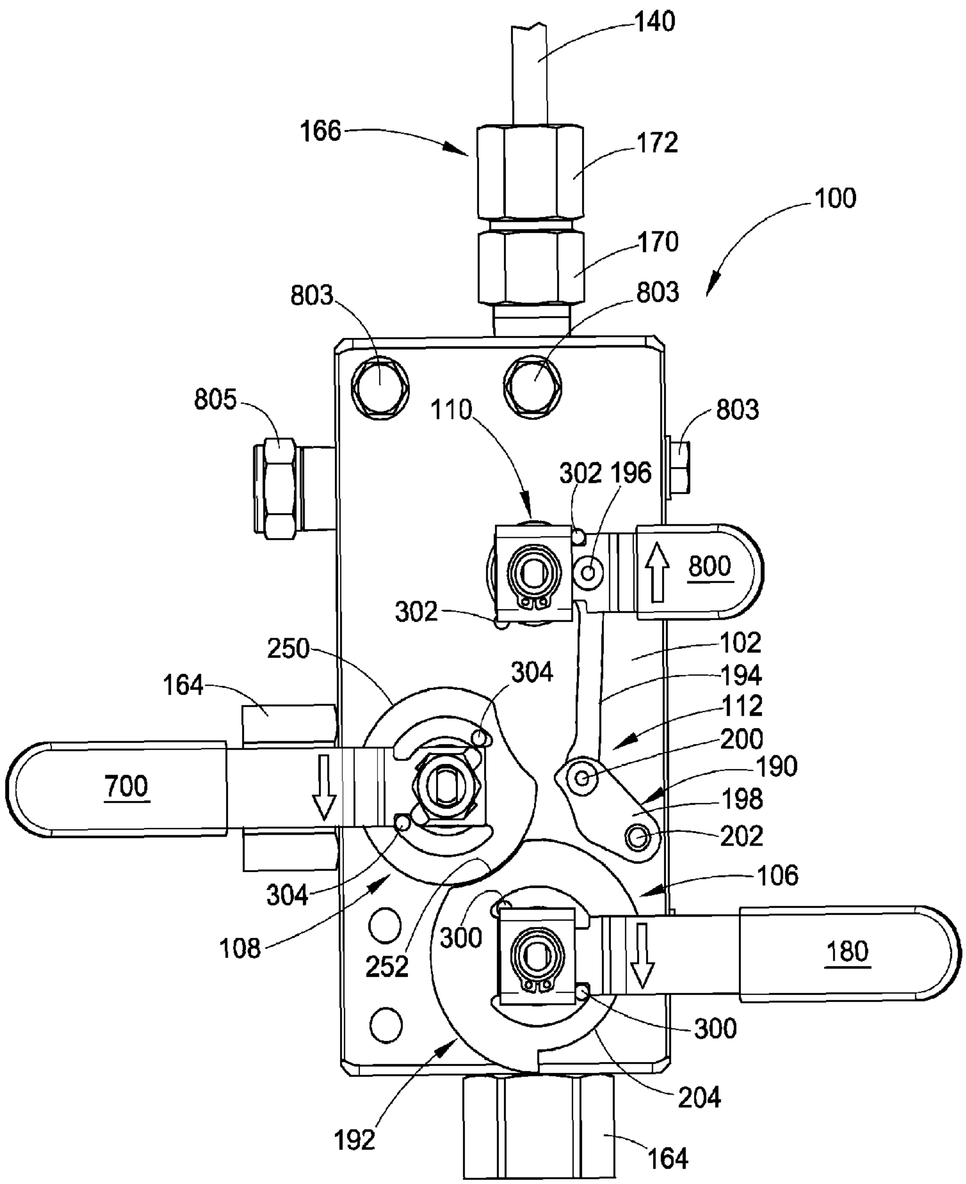

140
166
172
100
170
803
803
805
110
803
302 196
800
302
102
250
304
194
164
112
200
700
190
198
202
304
106
108
300
252
180
300
204
192
164

FIG. 10A

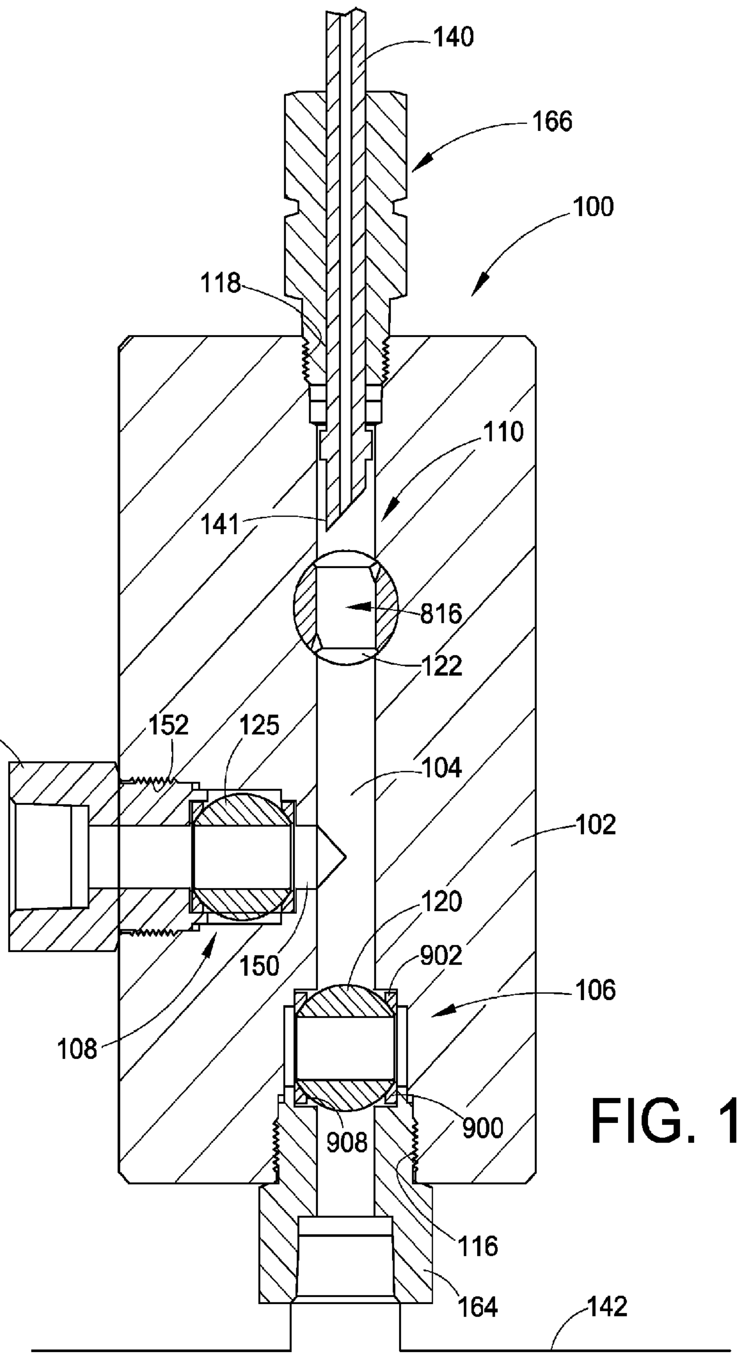

140
166
100
118
110
141
816
122
164
152
125
104
102
120
902
106
150
108
908
900
116
164
142

FIG. 10B

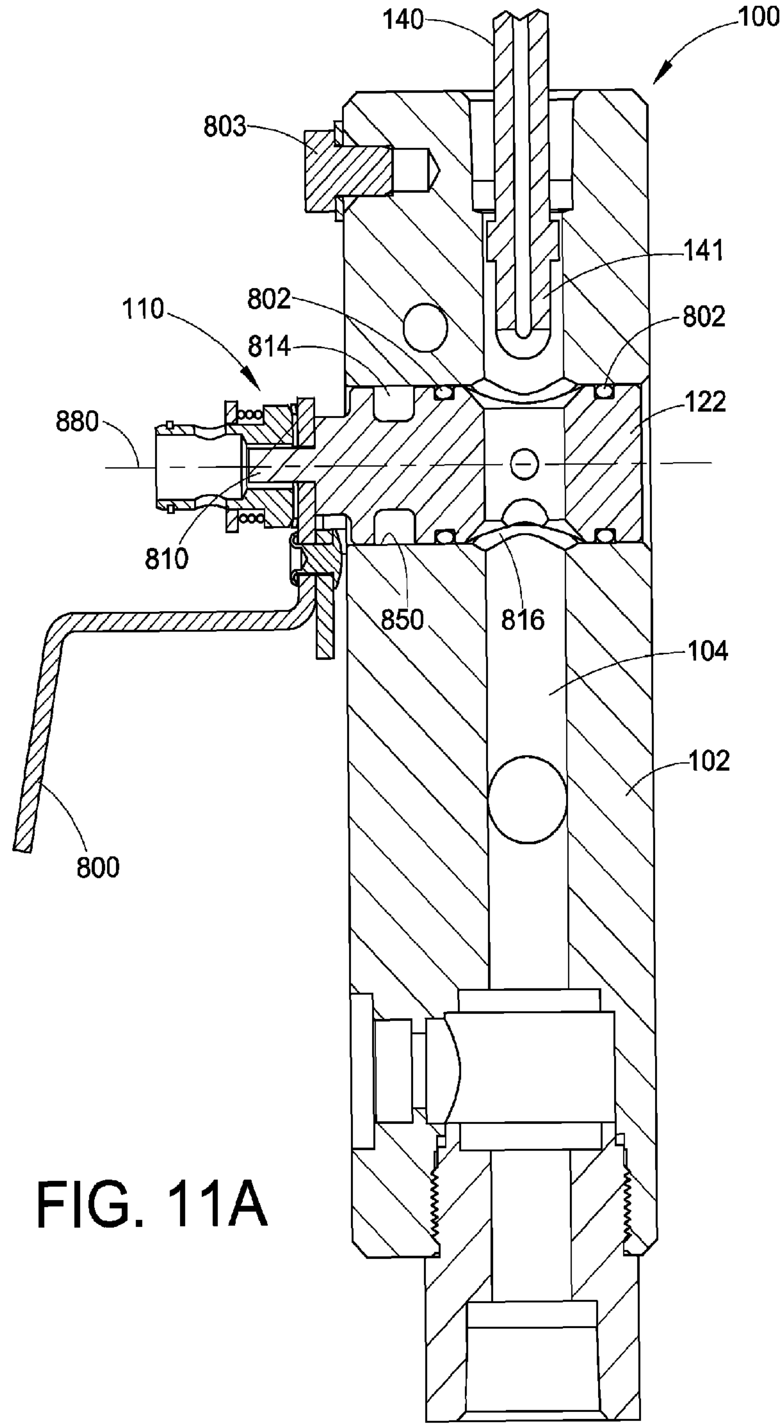


FIG. 11A

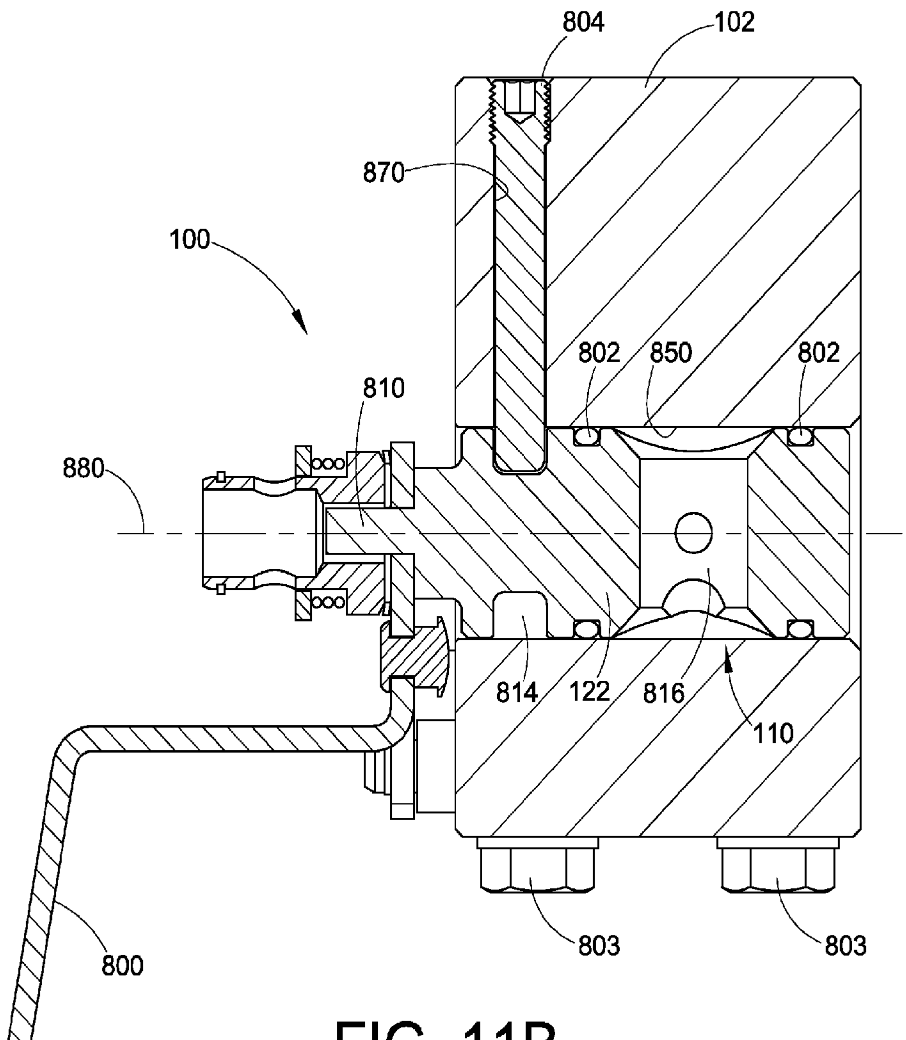


FIG. 11B

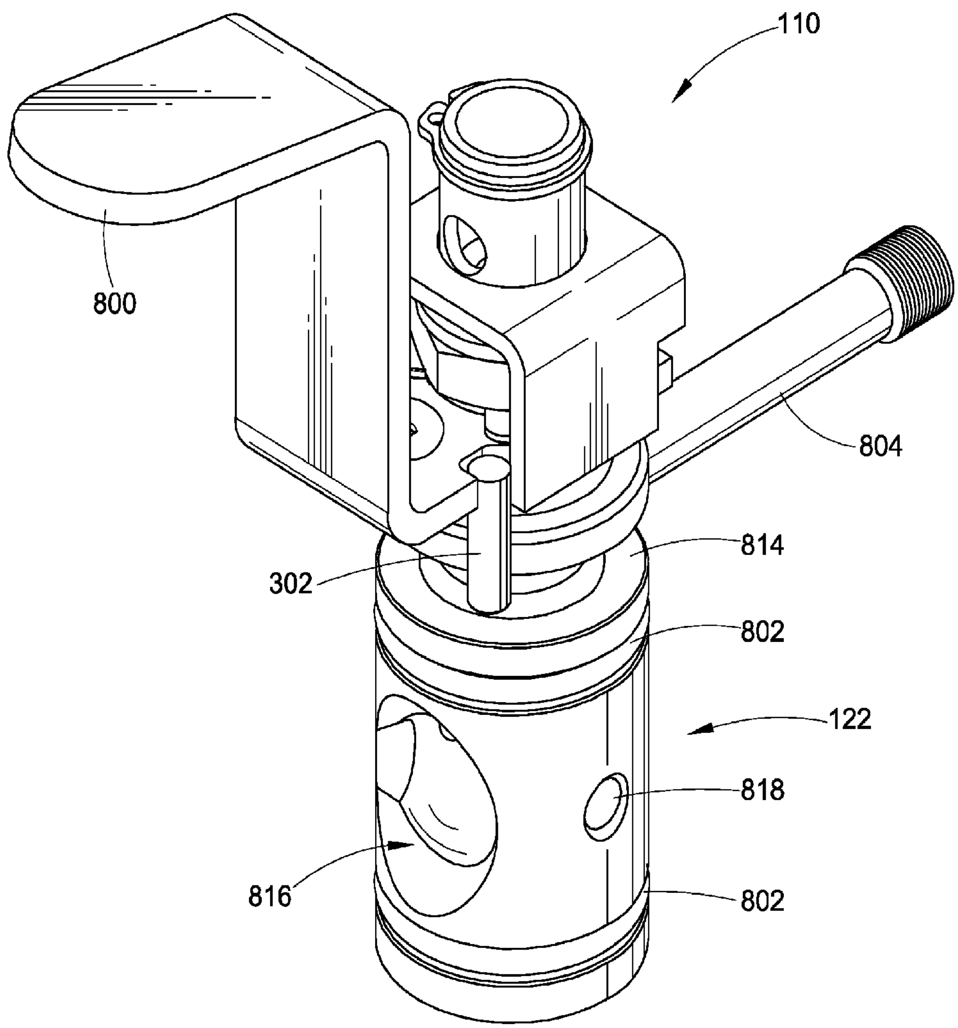


FIG. 11C

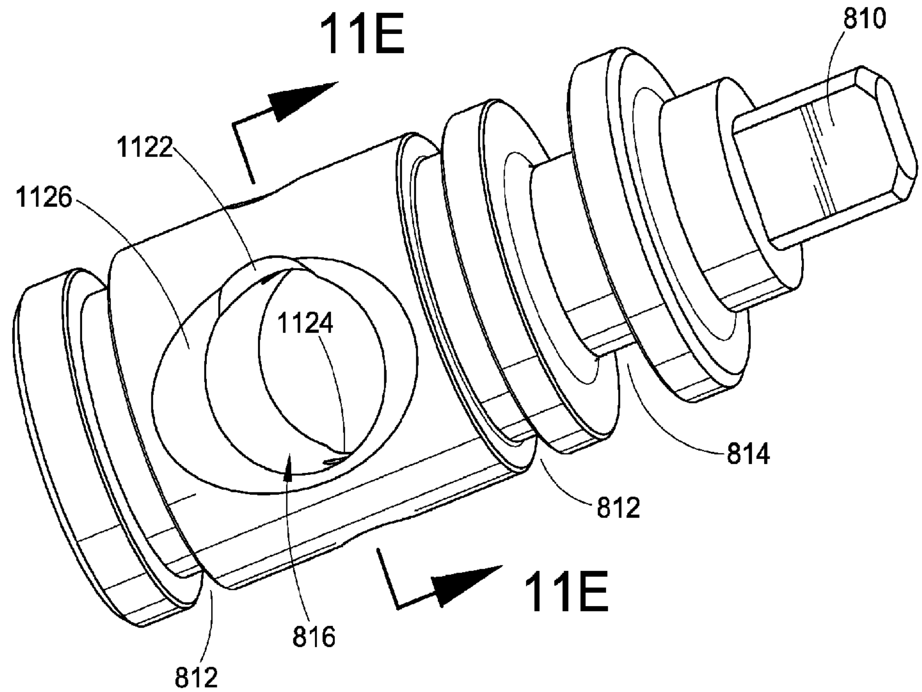


FIG. 11D

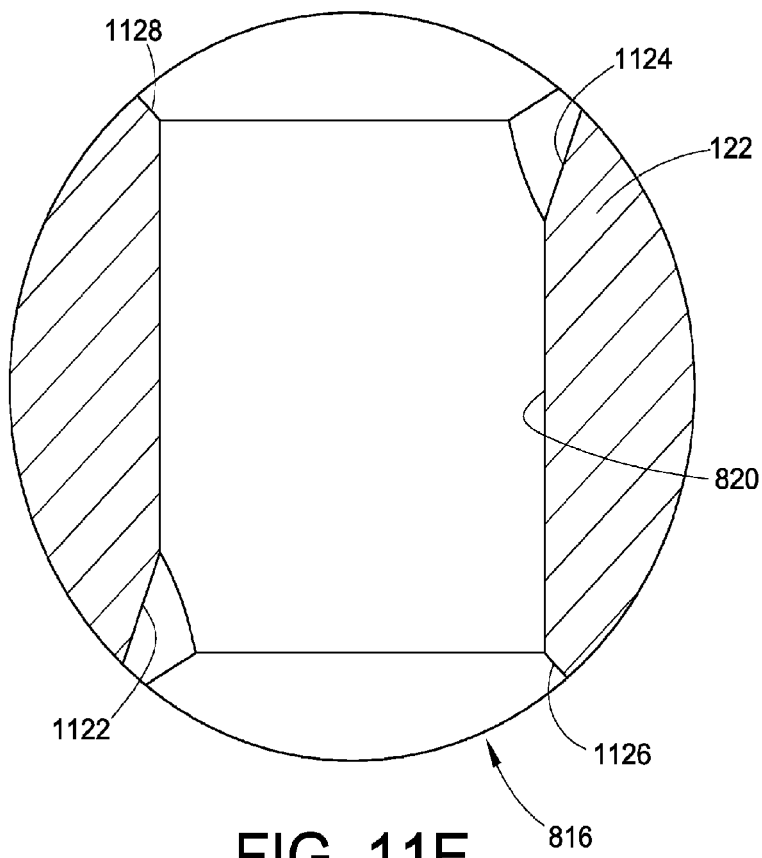


FIG. 11E

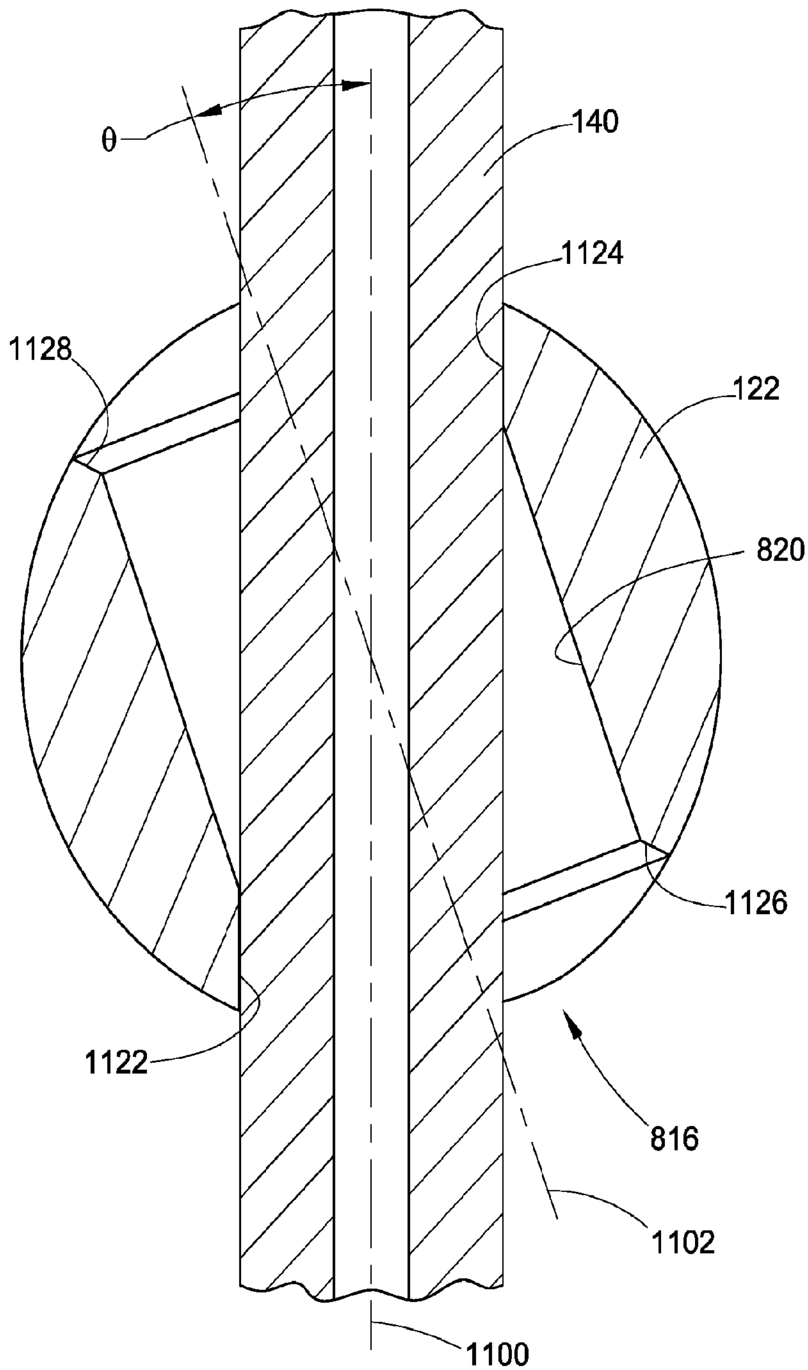


FIG. 11F

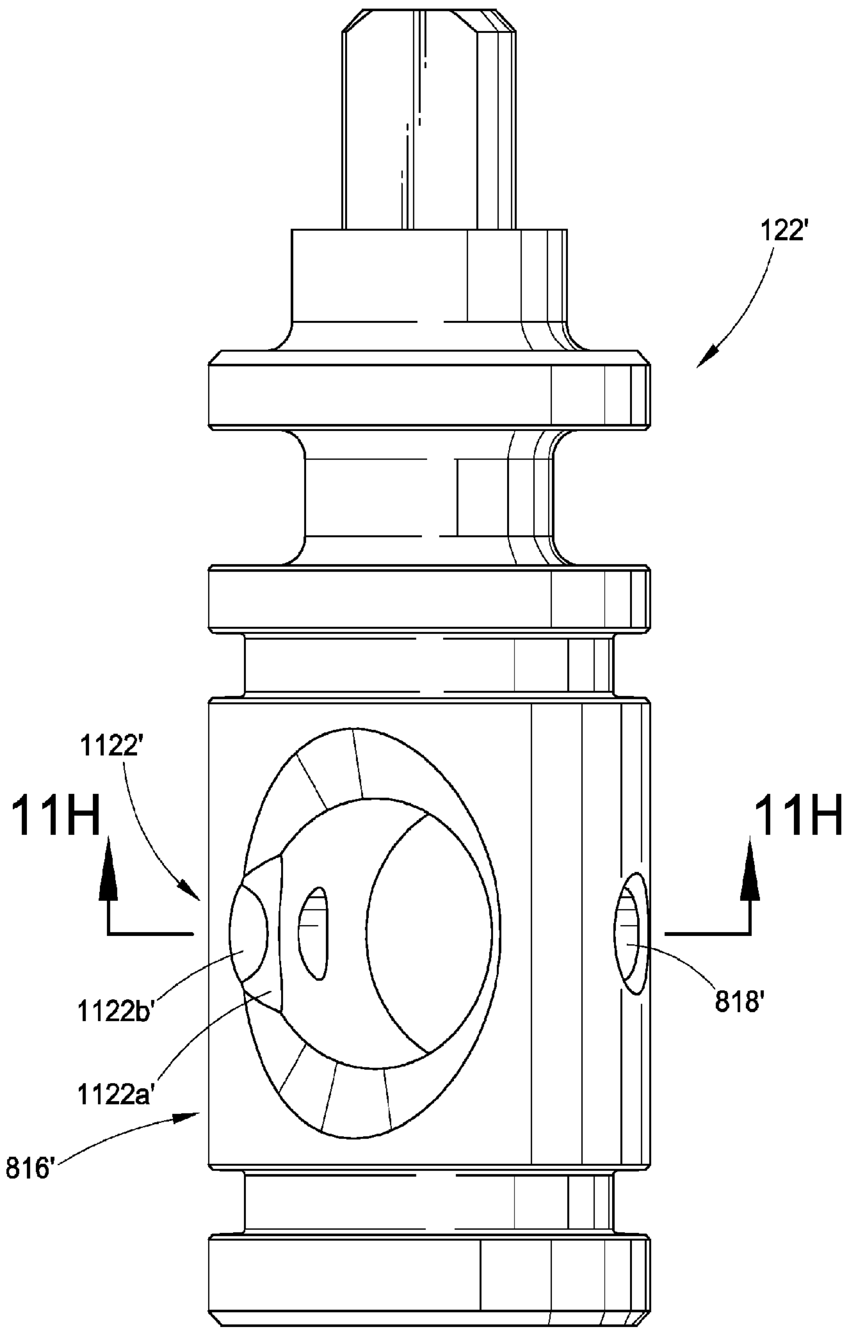


FIG. 11G

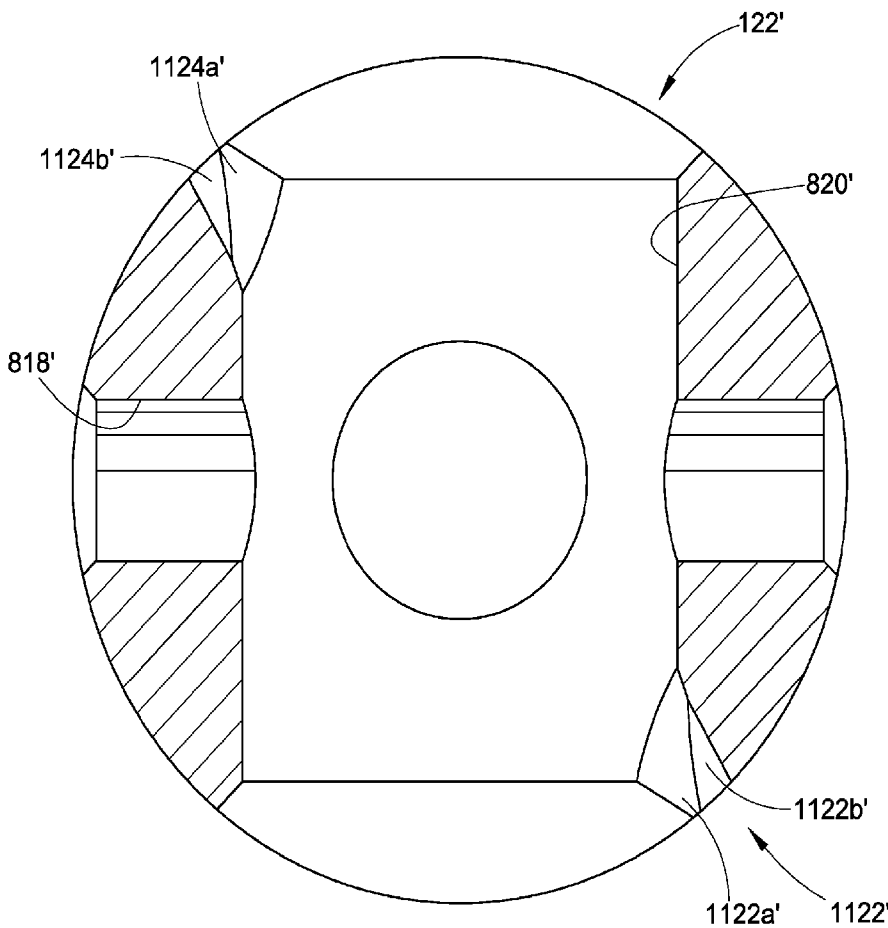


FIG. 11H

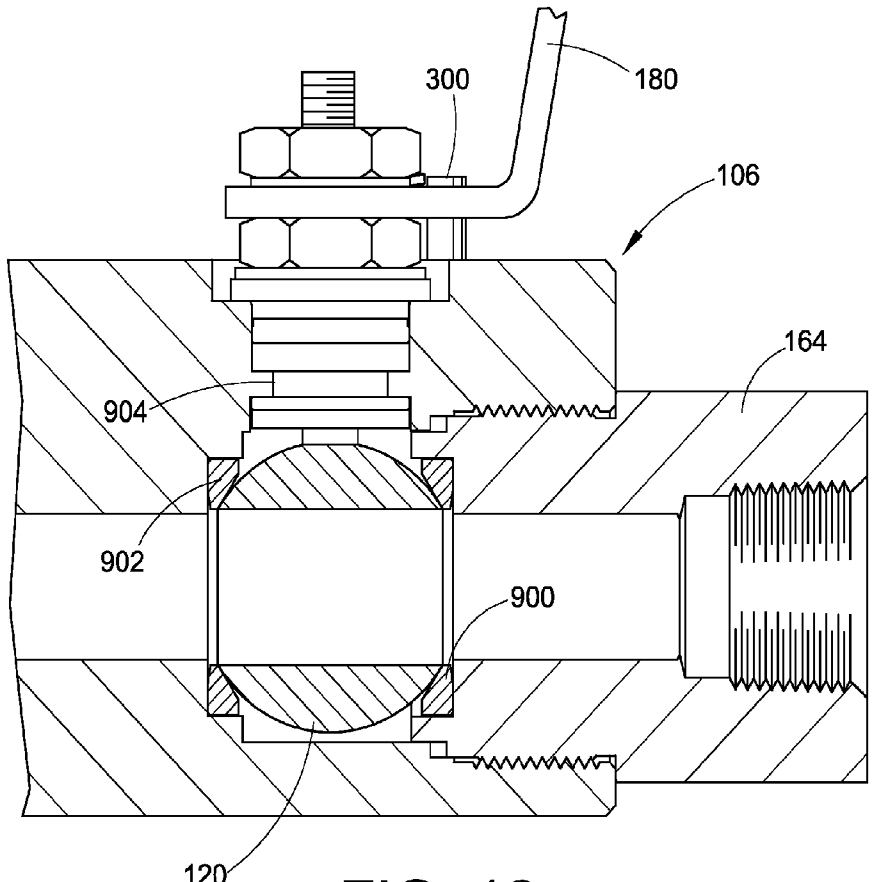


FIG. 12

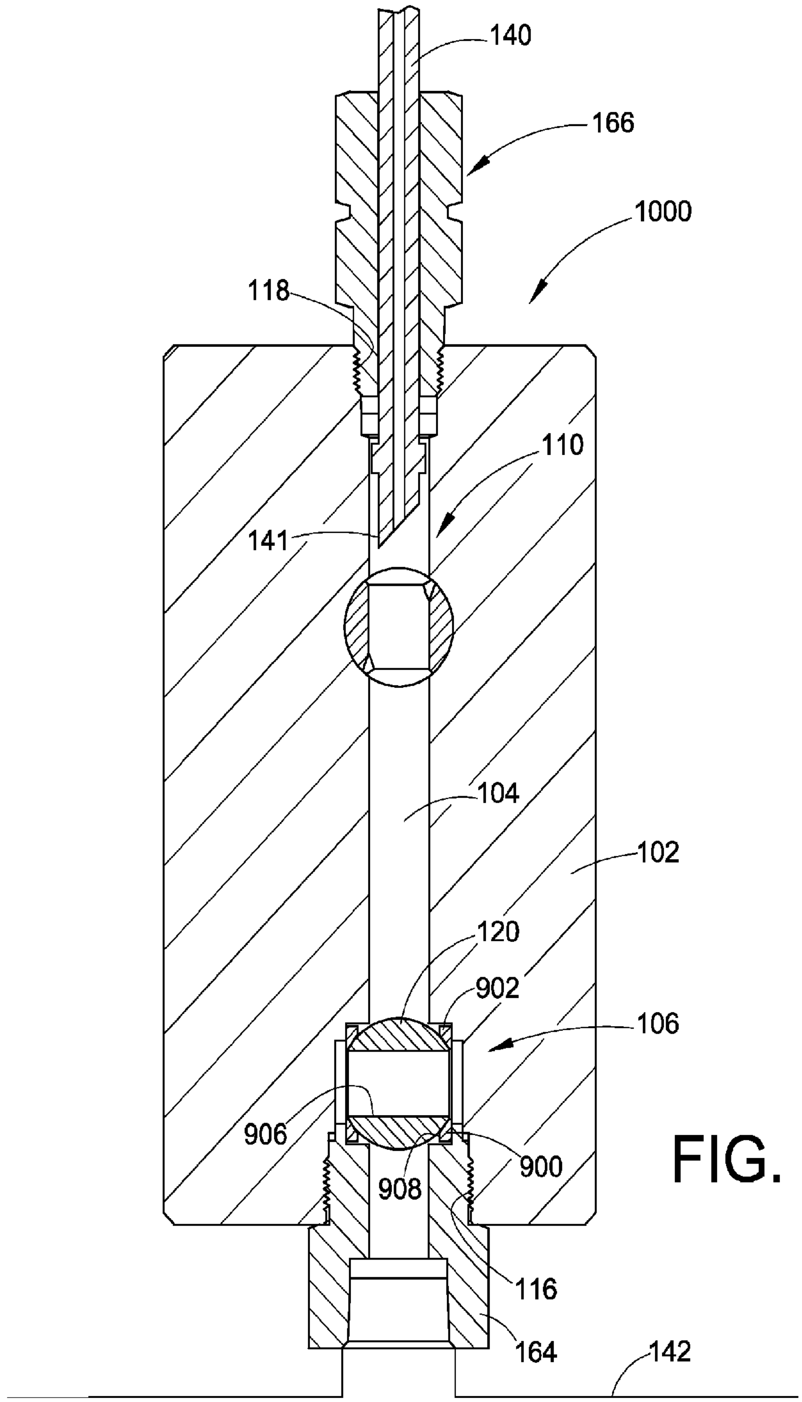

140
166
1000
118
110
141
104
102
120
902
106
906
900
908
116
164
142

FIG. 13

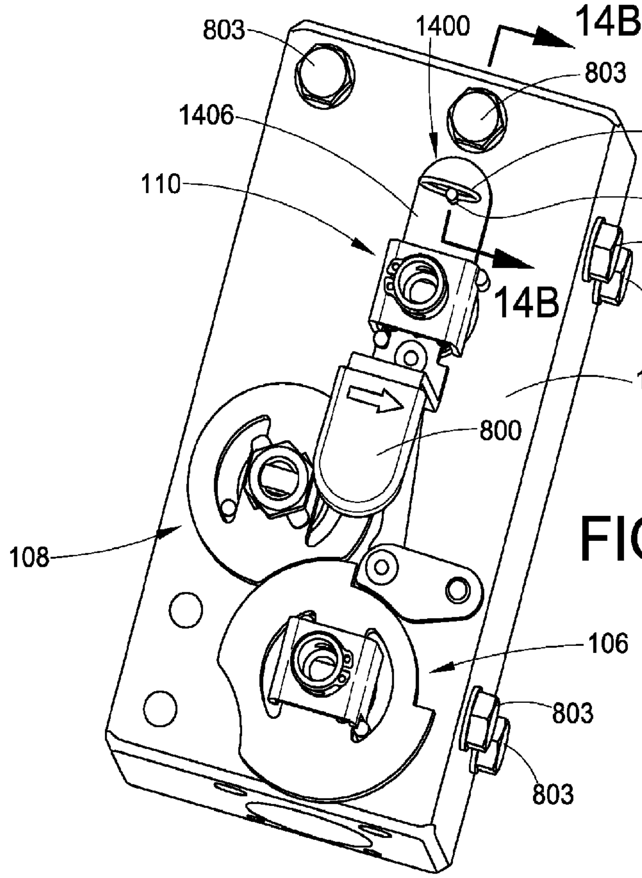
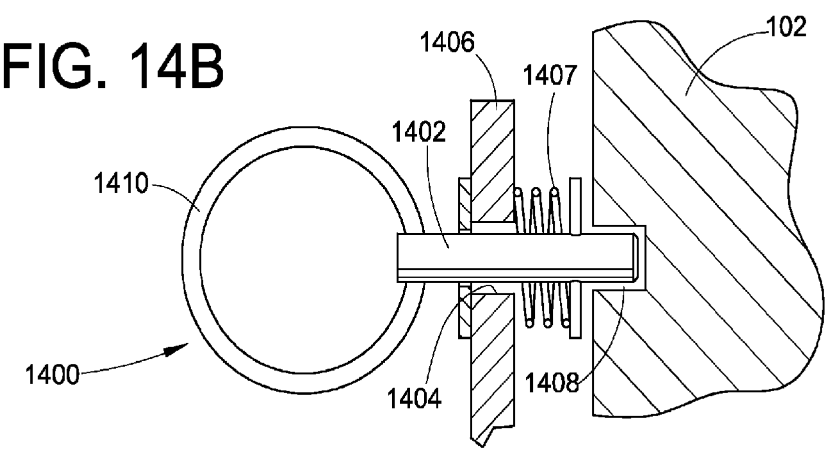


FIG. 14A

FIG. 14B



PROCESS INTERFACE VALVE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from U.S. Provisional Application Ser. No. 61/324,516, entitled "PROCESS INTERFACE VALVE ASSEMBLY," filed on Apr. 15, 2010, the entire disclosure of which is fully incorporated herein by reference.

FIELD OF THE INVENTION

The present application relates to valve assemblies. More particularly, in an exemplary embodiment, the application relates to valve assemblies that can be used to sample fluid from a process piping system.

BACKGROUND

Process interface valves are used to sample fluid from process piping systems. The sampled fluid is tested or analyzed. Process piping systems are used in a variety of different markets, including, but not limited to, oil and gas, chemical, petrochemical, and power generation markets.

One existing series of process interface valves is the KENMAC® series of process interface valves available from Swagelok®. For example, the KENMAC® VB04 valves include first and second block valves disposed in a process fluid access passage and a bleed valve disposed in a vent passage that branches off of the fluid access passage. A probe can be inserted through the first and second block valves and into communication with the process fluid. The process fluid is then sampled through the probe and analyzed. A wide variety of existing instrumentation can be used for the analysis of the process fluid.

SUMMARY

According to an aspect of one or more of the inventions, a valve (for example, a process interface valve) may be configured to receive an element (for example, a probe, tool, fluid, or other media) through an access port for delivery of the element through the open valve. To prevent the valve assembly from being inadvertently operated when the element is extending through the valve, an access blocking device may be disposed in the process fluid access passage to selectively block insertion of the element.

In accordance with an embodiment of one or more of the inventions presented in this disclosure, a valve assembly includes a valve body having a fluid access passage extending from a process fluid port to an access port, a block valve disposed in the fluid access passage and movable between open and closed conditions, an access blocking device disposed in the fluid access passage between the access port and the block valve, and a valve interlock arrangement. The access blocking device is movable from an access blocking condition in which access to the block valve through the access port is blocked, to an access permitting condition in which access to the block valve through the access port is permitted. The valve interlock arrangement is configured such that the block valve is prevented from being moved to the closed condition when the access blocking device is in the access permitting condition.

According to another aspect of one or more of the inventions, a valve interlock arrangement may additionally or alternatively be configured to prevent movement of an access blocking device to an access permitting condition when the fluid control valve is in a closed condition, thereby preventing an impact between an element inserted through an access port and a closed valve element.

According to still another aspect of one or more of the inventions, a method is described for preventing damage to a probe insertable into an access port of a process interface valve assembly and through an open block valve of the process interface valve assembly. In one such method, an indication that the probe may have been inserted through the block valve is provided. Operation of the block valve from an open condition toward a closed condition is prevented in response to the indication that the probe may have been inserted into the block valve. In another method, an indication that the block valve is in the closed condition is provided, and operation of a probe blocking device from a probe blocking condition to a probe accepting condition is prevented in response to the indication that the block valve is in the closed condition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a schematic illustration of a process interface valve and interlock assembly with a block valve in a closed position;

FIG. **1**B illustrates the process interface valve and interlock assembly of FIG. **1**A with the block valve in an open position and a probe inserted through the block valve;

FIG. **2** is a flow chart illustrating operation of a probe access valve interlock assembly;

FIG. **3** is a flow chart illustrating operation of a probe access valve interlock assembly;

FIG. **4**A is a perspective view of an exemplary embodiment of a process interface valve assembly and a probe;

FIG. **4**B is an enlarged front view of the process interface valve assembly shown in FIG. **4**A;

FIG. **4**C is an enlarged sectional view taken along the plane indicated by lines **4**C-**4**C in FIG. **4**A;

FIG. **5** is a view of the process interface valve assembly illustrating a probe blocking device being moved from a probe blocking position toward a probe accepting position;

FIG. **6**A is a front view of the process interface valve assembly illustrating a block valve moved from a closed position to an open position;

FIG. **6**B is an enlarged sectional view of the process interface valve assembly shown in FIG. **6**A;

FIG. **7** is a front view of a process interface valve assembly illustrating a probe blocking device moved to a probe accepting position, with the handles of the block valve and probe blocking device shown in phantom to illustrate additional features of the assembly;

FIG. **8** is an enlarged sectional view of the probe interface valve assembly shown in FIG. **7**, with a probe inserted through the probe interface valve assembly;

FIG. **9** is a sectional view similar to FIG. **8** illustrating the probe blocking device moved from the probe accepting position toward the probe blocking position;

FIG. **9**A is an enlarged portion of FIG. **9** as indicated by reference **9**A in FIG. **9**;

FIG. **10**A is a front view of a process interface valve assembly, illustrating a bleed valve moved from a closed position to an open position;

FIG. **10**B is a sectional view of the process interface valve assembly shown in FIG. **10**A;

FIG. **11**A is a sectional view illustrating components of an exemplary embodiment of a probe blocking device;

FIG. **11**B is another sectional view of the probe blocking device of FIG. **11**A;

FIG. **11**C is a perspective view illustrating components of the probe blocking device of FIG. **11**A;

FIG. **11**D is a perspective view illustrating an exemplary embodiment of a probe blocking member;

FIG. **11**E is a sectional view taken along the plane indicated by lines **11**E-**11**E in FIG. **11**D;

FIG. **11**F is a view similar to the view of FIG. **11**E showing the probe blocking member turned from a probe accepting position toward a probe blocking position and into engagement with the probe;

FIG. **11**G is a perspective view illustrating an exemplary embodiment of another probe blocking member;

FIG. **11**H is a sectional view taken along the plane indicated by lines **11**H-**11**H in FIG. **11**G;

FIG. **12** is a enlarged sectional view showing ball valve components that can be used in the process interface valve;

FIG. **13** is a sectional view of an embodiment of another process interface valve assembly;

FIG. **14**A is a perspective view of a process valve assembly with a probe blocking assembly having a locking mechanism (handles of the block valve and the bleed valve are removed); and

FIG. **14**B is a schematic illustration of the locking mechanism shown in FIG. **14**A as indicated by section lines **14**B-**14**B in FIG. **14**A.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

While the inventions are described herein with specific reference to a variety of structural and material features, such descriptions are intended to be exemplary in nature and should not be construed in a limiting sense. For example, the exemplary embodiments are described primarily in terms of ball valve assemblies. Those skilled in the art, however, will readily appreciate that any one or more of the aspects and features of the inventions may be used with a valve assemblies that include one or more of a wide variety of different types of valves. Further, the components of the process interface valve assemblies can be made from any suitable materials. For example, all of the components that contact the process fluid can be made from metal, such as stainless steel, carbon steel, duplex steel, or any other metal and/or from polymers, such as plastics (including, for example, PTFE, FEP, PFA, etc.) and elastomers. The materials of the components of the process interface valve assemblies can be selected based on the intended application.

Further, while the exemplary embodiments described herein are identified as process interface valve assemblies for sampling fluid from a process piping system using a probe inserted through the valve assembly, with a mechanical valve interlock preventing rotational closure of a block valve element on the inserted probe, other valve assemblies and systems may utilize one or more of the inventive features described in the present application. For example, a valve assembly may be configured to receive some other tool, medium, or other such element therethrough, for which closure of the valve assembly in this element receiving condition may be undesirable. As another example, a valve interlock arrangement, as used herein, may include any type of arrangement or device configured to restrict or control operation of a first device (such as a block valve or probe blocking device) as a function of a state of a second device (such as a block valve or probe blocking device), such as an operational position of the second device, or the presence of an inserted element within the second device. For example, many types of mechanical, electrical, electromechanical, magnetic, or fluid driven valve interlock arrangements may be utilized to prevent closure of a valve element on an inserted element. As still another example, a mechanical interlock arrangement utilizing one or more of the features described herein may be provided to limit the corresponding conditions of two or more rotationally adjustable devices, including, for example, shutoff valves, multidirectional valves, regulating valves, blocking devices, electrical knobs, and other such devices.

While various inventive aspects, concepts and features of the inventions may be described and illustrated herein as embodied in combination in the exemplary embodiments, these various aspects, concepts and features may be used in many alternative embodiments, either individually or in various combinations and sub-combinations thereof. Unless expressly excluded herein all such combinations and subcombinations are intended to be within the scope of the present inventions. Still further, while various alternative embodiments as to the various aspects, concepts and features of the inventions—such as alternative materials, structures, configurations, methods, circuits, devices and components, hardware, alternatives as to form, fit and function, and so on—may be described herein, such descriptions are not intended to be a complete or exhaustive list of available alternative embodiments, whether presently known or later developed. Those skilled in the art may readily adopt one or more of the inventive aspects, concepts or features into additional embodiments and uses within the scope of the present inventions even if such embodiments are not expressly disclosed herein. Additionally, even though some features, concepts or aspects of the inventions may be described herein as being a preferred arrangement or method, such description is not intended to suggest that such feature is required or necessary unless expressly so stated. Still further, exemplary or representative values and ranges may be included to assist in understanding the present disclosure, however, such values and ranges are not to be construed in a limiting sense and are intended to be critical values or ranges only if so expressly stated. Moreover, while various aspects, features and concepts may be expressly identified herein as being inventive or forming part of an invention, such identification is not intended to be exclusive, but rather there may be inventive aspects, concepts and features that are fully described herein without being expressly identified as such or as part of a specific invention, the inventions instead being set forth in the appended claims. Descriptions of exemplary methods or processes are not limited to inclusion of all steps as being required in all cases, nor is the order that the steps are presented to be construed as required or necessary unless expressly so stated.

FIGS. **1**A and **1**B schematically illustrate an exemplary embodiment of a process interface valve assembly **100** with an exemplary valve interlock arrangement **112**. The illustrated process interface valve assembly **100** includes a valve body **102**, a process fluid access passage **104**, and a block valve **106**. The process fluid access passage **104** extends through the valve body **100** from a process fluid port **116** to an access port or probe port **118**. The illustrated block valve **106** includes a valve element **120** disposed in the process fluid access passage **104**. The block valve **106** is operable to selectively open (see FIG. **1**B) and close (see FIG. **1**A) the fluid access passage **104**.

According to an aspect of the present application, an assembly including first and second devices may be provided with an interlock arrangement configured such that operability of one of the first and second devices is a function of an operational state of the other of the first and second devices. In one embodiment, a valve interlock arrangement associated with a block valve and a probe blocking device is configured such that operability of one of the block valve and the probe blocking device is a function of an operational state of the other of the block valve and the probe blocking device. As one example, the valve interlock arrangement may be configured such that the block valve is prevented from being moved to or toward a closed condition when the probe blocking device is in a probe accepting condition, with the block valve being permitted to move to or toward the closed condition when the probe blocking device is in a probe blocking condition. As another example, the valve interlock arrangement may additionally or alternatively be configured such that the probe blocking device is prevented from being moved to or toward the probe accepting condition when the block valve is in the closed condition, with the probe blocking device being permitted to move to or toward the probe accepting condition when the block valve is in the open condition.

Referring to FIG. **2**, in one exemplary embodiment, the valve interlock arrangement **112** changes state **10** depending on whether the valve is open or the valve is closed. If the valve is open, the valve interlock arrangement **112** allows **12** insertion of a probe **140** through the block valve **106** (see FIG. **1**B). If the valve **106** is closed, the valve interlock arrangement **112** prevents **14** insertion of the probe **140** to the block valve. This may inhibit potential damage to the block valve **106** and/or the probe **140**.

Referring to FIG. **3**, in another exemplary embodiment, the valve interlock arrangement **112** of FIGS. **1**A and **1**B changes state **16** depending on whether or not the probe **140** could be disposed in the block valve **106**. If the probe **140** could not be disposed in the block valve **106**, the interlock arrangement **112** allows **18** the block valve **106** to close. If the probe **140** could be disposed in the block valve **106**, the interlock arrangement **112** prevents **20** the block valve **106** from closing. This prevents the block valve **106** from potentially crimping or otherwise damaging the probe **140**.

In another embodiment, the valve interlock arrangement **112** performs the functions illustrated by FIG. **2** and the functions illustrated by FIG. **3**. In this embodiment, the probe **140** is inhibited from being inserted into contact with a closed block valve **106** and a probe in an open block valve is inhibited from being damaged by moving the block valve from the open position toward the closed position.

The valve interlock arrangement **112** may take a wide variety of different forms. For example, any type of sensor may be employed to sense the position of the block valve **106** and/or the probe **140**. The output of such a sensor or sensors may be used to control a mechanism that selectively inhibits movement of the probe **140** and/or the block valve **106**. The valve interlock arrangement may comprise one or more mechanical linkages that selectively inhibit movement of the block valve **106** based on the position or possible positions of the probe **140** and/or that selectively inhibit movement of the probe based on the position of the block valve. The output of a sensor or sensors may be provided to a controller or computer that automatically controls the valves. The controller or computer may be programmed to selectively inhibit movement of the block valve based on the position or possible positions of the probe **140** and/or that selectively inhibit movement of the probe based on the position of the block valve. Any arrangement that performs one or more of the functions illustrated by FIGS. **2** and **3** can be employed.

In FIGS. **1**A and **1**B, the valve interlock arrangement **112** is schematically illustrated and includes a probe interface component **30** that is linked to a block valve interface component **32**. In one exemplary embodiment, the block valve interface component **32** provides an indication of whether the block valve **106** is open or closed. The probe interface component **30** is linked to the block valve interface component **32**, such that the probe interface component **30** allows insertion of the probe when the block valve interface component indicates that the block valve **106** is open and prevents insertion of the probe when block valve interface indicates that the block valve is closed.

In one exemplary embodiment, the probe interface component **30** provides an indication of whether the probe **140** is or could be disposed in the block valve **106**. The probe interface component **30** is illustrated as being downstream of the block valve **106**, but could be disposed at the block valve **106** or any other suitable location. The block valve interface component **32** is linked to the probe interface component **30**, such that the block valve interface component **32** inhibits movement of the block valve toward the closed position when the probe is or could be disposed in the block valve and allows the block valve to close when the probe is not or could not be disposed in the block valve.

The probe interface component **30** may take a wide variety of different forms. For example, the probe interface component **30** may be a sensor that provides an indication of the presence or position of the probe. The probe interface component **30** may be a blocking member or mechanism that selectively blocks the process fluid passage **104**. In the embodiment represented by FIG. **2**, such a blocking member or mechanism would selectively allow or prevent insertion of the probe **140**. In the embodiment represented by FIG. **3**, such a blocking member or mechanism would provide an indication of whether the probe could be in the block valve, since the probe could not be in the block valve if the process fluid passage is blocked (for example, by an access blocking device).

The valve interface component **32** may take a wide variety of different forms. For example, the valve interface component **32** may be a sensor that provides an indication of the position of the block valve **106** or a component that moves as the valve **106** moves from the open position to the closed position.

The process interface valve assembly **100** with a valve interlock arrangement **112** can take a wide variety of different forms. FIGS. **4**A-**4**C provide a non-limiting example of a process interface valve assembly **100** that includes an interlock arrangement **112**. However, the process interface valve assembly **100** and the valve interlock **112** can take a wide variety of different forms. In the example of FIGS. **4**A-**4**C, process interface valve assembly **100** includes a valve body **102**, a process fluid access passage **104** (FIG. **4**C), a block valve **106**, and an optional bleed valve **108**. While the exemplary valve body **102** is shown as a single unitary body in which the block valve **106**, bleed valve **108**, and probe blocking device **110** are installed, in other embodiments, a valve body may be formed from multiple bodies detachably or permanently assembled with each other. For example, a valve body may be formed from the bodies of separate block valve, bleed valve, and probe blocking devices.

In the example illustrated by FIGS. **4**A-**4**C, the probe interface component **30** (see FIG. **1**A) of the valve interlock arrangement **112** comprises an access blocking device or probe blocking device **110**. The probe blocking device **110** has a probe blocking member **122** (FIG. **4**C) disposed in the process fluid access passage between the probe port **118** and the block valve element **120**. The probe blocking device **110** is moveable from an access blocking or probe blocking position where a probe is prevented from being inserted through the probe port **118** past the blocking member **122** of the probe blocking device **110** (see FIG. **4**C) to an access permitting or probe accepting position where the probe is insertable through the probe port past the probe blocking device **110** (see FIG. **8**).

Referring to FIG. **4**C, when the block valve **106** is closed, a process fluid is prevented from flowing in the fluid access passage past the valve element **120**. Referring to FIG. **8**, when the block valve **106** is open and the probe blocking device **110** is in the probe accepting position **110**, a probe **140** can be inserted into a process fluid vessel or conduit **142**, such as a pipe. In the illustrated embodiment, the valve interlock arrangement **112** is configured such that the block valve **106** is prevented from being moved from the open position to the closed position when the probe blocking device **110** is in the probe accepting position (see FIG. **7**). This prevents the block valve **106** from being closed while the probe **140** is disposed in the valve member **120** of the block valve **106**.

In the embodiment illustrated by FIGS. **4**A-**4**C, the process interface valve assembly **100** includes the optional bleed valve **108**. FIG. **13** illustrates an embodiment of a process interface valve assembly **1000** that does not include the optional bleed valve **108**. The process interface valve assembly **1000** is not described in detail, since all of its components are included in the process interface valve assembly **100**.

Referring to FIG. **4**C, when the optional bleed valve **108** is included, a bleed passage **150** is defined in the valve body **102**. The bleed passage **150** extends from a bleed port **152** to the process fluid access passage **104**. The bleed valve **108** has a valve element **125** disposed in the bleed passage **150**. The bleed valve **108** is operable to selectively open and close the bleed passage **150**. In the FIG. **4**C example, the valve element **120** of the block valve **106** is disposed between the process fluid port **116** and the bleed passage **150**. In the FIG. **4**A-**4**C embodiment, the valve interlock arrangement **112** is configured such that the bleed valve **108** is prevented from being opened when the block valve is open (see FIG. **6**A) and the block valve is prevented from being opened when the bleed valve is open (see FIG. **10**A).

The valve body **102** can take a wide variety of different forms. Any structure that provides an interface to the process fluid vessel or conduit **142** can be used. In the illustrated embodiment, the fluid access passage **104** is straight. In other embodiments, the fluid access passage may be curved or have a curved portion. For example, the fluid access passage **104** may be curved or have a curved portion if the probe is flexible.

The process fluid port **116** may take a wide variety of different forms. For example, the process fluid port **116** may be any structure configured to couple with any type of fitting capable of coupling the fluid access passage **104** to the process fluid vessel or conduit **142**. In the illustrated embodiment, the process fluid port **116** comprises internal threads (see FIG. **4**C) that accept an end screw **164**.

A wide variety of different types of probes can be used with the process interface valve assembly. The illustrated probe **140** comprises an elongated tube having a first open end **141** with a valve **143** coupled to a second end (see FIG. **4**A). The valve **143** can be opened and closed to control fluid flow through the probe. In other embodiments, other insertable elements, such as sensors, cameras, or other tools, or other materials or media, may be used with a valve assembly as described herein.

The access port or probe port **118** may take a wide variety of different forms. For example, the probe port **118** may be any structure configured to couple with any type of fitting **166** capable of accepting and sealing around a probe **140**. In an exemplary embodiment, the probe fitting **166** is configured to maintain the seal with the probe **140**, when the probe is moved in the process passage **104** as indicated by arrows **168** in FIG. **4**C. A wide variety of existing fittings can be used as the probe fitting. In the illustrated embodiment, the probe port comprises internal threads (see FIG. **4**C) that accept a first component **170** of the probe fitting **166**. A second component **172** of the fitting may be tightened to the first fitting component **170** to form a seal around the probe **140** in a well known manner. For example, tightening the first fitting component **170** with the second fitting component **172** may compress a seal member or packing to form a seal around the probe **140**.

The block valve **106** may take a wide variety of different forms. Examples of different types of valves that may be used include, but are not limited to, ball valves, plug valves, shuttle valves, needle valves, gate valves, spool valves and the like. Any type of valve capable of opening and closing the fluid access passage **104** can be used. In an exemplary embodiment, the valve also allows the probe **140** to be inserted past the block valve in the fluid access passage.

The illustrated block valve **106** is a ball valve. A wide variety of different ball valve configurations may be used. One suitable ball valve configuration is the configuration of the VB04 ball valve modules of the KENMAC® series of process interface valves available from Swagelok®. FIG. **12** is an enlarged cross-sectional illustration of components of the block valve **106**. The block valve **106** includes the valve element **120**, a first valve seat **900**, a second valve seat **902**, and a valve stem **904**. The illustrated valve element **120** is spherical and includes a flow passage **906**. The illustrated valve seats **900, 902** are annular with a central openings **908**. The valve seat **900** seals against the valve element **120** and the end screw **164**. The valve seat **902** seals against the valve body **102** and the valve element **120**. The valve stem **904** is coupled to the valve element **120** and a block valve handle **180**. Rotation of the handle **180** rotates the valve stem **904** to rotate the valve element to the open and closed positions. In the open position, the central openings **908**, **910** are aligned with the flow passage **906** to allow fluid flow (see FIG. **6**B). In the closed position, the flow passage **906** is misaligned with (or does not overlap with) the central openings **908**, **910** to prevent flow (see FIG. **4**C).

In the illustrated embodiment, the block valve **106** is limited to ninety degrees of rotation between the closed position (see FIG. **4**B) and the open position (see FIG. **6**A). This can be accomplished in a wide variety of different ways. In the illustrated embodiment, stop pins **300** are disposed in the valve body **102**. The stop pins **300** are positioned to engage the block valve handle **180** at the open and closed positions.

The access blocking or probe blocking device **110** can take a wide variety of different forms. Any arrangement capable of selectively preventing and allowing probe insertion to the block valve **106** can be used. The probe blocking device **110** may prevent or allow fluid flow between the probe port **118** and the block valve **106** when the probe blocking device is in the probe blocking position. A valve may be used as the probe blocking device if the probe blocking device **110** is intended to prevent fluid flow between the probe port **118** and the block valve **106** when the probe blocking device is in the probe blocking position. Examples of types of valves that may be used as the probe blocking device **110** include, but are not limited to, ball valves, plug valves, shuttle valves, needle valves, and the like. Examples of types of mechanisms that may be used as the probe blocking device **110** if the probe blocking device is not intended to prevent fluid flow between the probe port **118** and the block valve **106** include, but are not limited to, rotary and/or linear devices having a passage that is selectively alignable with the process fluid passage **104** and devices having blocking portions that are selectively moveable into the process fluid passage, such as devices that include a blocking pin or other blocking member sufficient to obstruct insertion of a probe or other insertable element into the block valve **106**.

FIGS. **11**A-**11**C are illustrations of an exemplary embodiment of an access blocking or probe blocking device **110**. The illustrated probe blocking device **110** includes the probe blocking member **122**, a handle **800**, seal rings **802**, and a retention pin **804**. Referring to FIGS. **11**A and **11**B, the probe blocking member **122** is cylindrical with an integral stem **810**. First and second annular seal recesses **812** are defined in the probe blocking member **122**. An annular retention recess **814** is defined in the probe blocking member **122**. The probe blocking member **122** includes a probe passage **816**. The probe passage **816** may take any form that allows the probe **140** to be inserted through the probe blocking member **122**. In one exemplary embodiment, the probe passage **816** is configured to reduce stress applied to the probe **140** when the probe blocking device is moved from the probe accepting position toward the probe blocking position to move the probe blocking member **122** into contact with the probe (see FIGS. **9** and **9**A). This reduced stress can be accomplished in a variety of different ways. For example, the probe passage can be configured to increase the contact area between the probe blocking member **122** and the probe **140** when the probe blocking device is moved from the probe accepting position toward the probe blocking position. In such an example, notches **822**, **824** in the edges of the cylindrical bore **820** may be oriented to provide surface contact between the outer surface of the probe and the edge of the central bore when the probe blocking member is rotated toward the probe blocking condition and into engagement with the inserted probe. This increases the contact area between the probe blocking member **122** and the probe **140** as compared to a substantially continuous cylindrical bore, to reduce the potential stress applied to the probe.

Referring to FIGS. **11**D-**11**F, a probe passage **816** may be configured to increase the contact area between the probe blocking member **122** and the probe **140** when the probe blocking device is moved from the probe accepting position toward the probe blocking position and against an inserted probe. In this embodiment, the contact area is increased by providing a probe passage **816** with a central cylindrical bore **820** and first and second notch areas **1122**, **1124**. The notch areas can take a wide variety of different forms. In one embodiment, the notch areas **1122**, **1124** have skewed cylindrical surfaces that match the outside surface of a cylindrical object. For example, the notch areas **1122**, **1124** may substantially correspond to an outer cylindrical surface of the probe **140** (see FIG. **11**F). However any shape that increases the contact area between the probe **140** and the bore can be used. Referring to FIG. **11**F, the illustrated notch areas **1122**, **1124** have a common central axis **1100** that is out of alignment with respect to a central axis **1102** of the cylindrical bore **820**. For example, an angle θ may be formed between the common central axis of the notch areas **1122**, **1124** and the central axis **1102** of the cylindrical bore **820**. The notch areas **1122**, **1124** increase the contact area between the probe blocking member **122** and the probe **140** as compared to a substantially continuous cylindrical bore to reduce the potential stress applied to the probe. In the embodiment illustrated by FIGS. **11**D-**11**F, the probe passage **816** also includes first and second chamfers **1126**, **1128**. The first and second chamfers **1126**, **1128** help to guide the probe end into the central cylindrical bore **820** during probe insertion and retraction.

In another embodiment, notched areas in the orifice of a probe blocking member may include discontinuous surfaces configured to accommodate probes of multiple sizes. For example, as shown in FIGS. **11**G and **11**H, a probe blocking member **122'** includes a probe passage **816'** with a notched area **1122'** having a first skewed cylindrical surface **1122***a'* contoured to correspond with a ⅜" diameter probe, and a second skewed cylindrical surface **1122***b'* contoured to correspond with a ¼" diameter probe, to allow for an increased contact surface for either size probe. Similar discontinuous skewed cylindrical surfaces may be provided at the opposite end of the central bore **820'**.

Other arrangements may be utilized to reduce or eliminate stress applied to the probe (or other insertable element) by the probe blocking member when the probe blocking device is moved from the probe accepting position toward the probe blocking position with the probe inserted into the probe blocking device. For example, a probe blocking member may include a softer or compressible material (e.g., a plastic or elastomer) that transmits less impact force to the inserted probe. As another example, a probe blocking device may be provided with a spring-loaded handle that prevents excessive impact force from being applied to the inserted probe, by deformation of a spring connecting the handle to the probe blocking member. In still other embodiments, a probe blocking device locking arrangement may be utilized to prevent movement of the probe blocking device toward the probe blocking condition when a probe is inserted into the probe blocking device. For example, a sensor may be utilized to detect the presence of a probe in the probe blocking device, and to deliver a signal to an electromechanical locking mechanism to prevent operation of the probe blocking device. As other examples, mechanical or magnetic latches triggered by insertion of the probe may also be used to lock the probe blocking device against movement toward the probe blocking condition.

Referring back to the exemplary embodiment of FIGS. **11**A-**11**C, the handle **800** is coupled to the integral stem **810**. The handle **800** is moveable to move the probe blocking member **122** to the probe blocking position (see FIG. **4**C) and to the probe accepting position (see FIG. **8**). In one exemplary embodiment, the handle **800** is configured to inhibit the application of excessive stress to the probe **140**. This can be accomplished in a wide variety of different ways. For example, the handle may be located in an area that is difficult to access when the probe **140** is inserted, the handle may be constructed such that it is difficult to apply a large force to the handle, for example by making the handle short and/or a clutch arrangement may be provided between the handle **800** and the probe blocking member **122**. In the illustrated embodiment, the handle **800** in the probe accepting position is positioned behind the block valve handle **180**, making it difficult to apply excessive force to the handle **800** when moving it from the probe accepting position toward the probe blocking position (see FIG. **7**). In addition, the handle **800** is significantly shorter than the handle of the block valve **106**.

To facilitate venting of the valve assembly and downstream tubing volume when the block valve **106** is closed and the bleed valve **108** is open, vent holes **818** may be provided in the probe blocking member **122**, as shown in FIG. **11**C. The vent holes **818** may extend substantially perpendicular to the probe passage **816**. The holes may be sized to be small enough to not allow passage of a probe (for example, smaller than ¼" in diameter), and large enough to readily vent the assembly.

Referring to FIGS. **11**A and **11**B, the probe blocking member **122** is disposed in a cylindrical bore **850**. Referring to FIG. **4**C, the cylindrical bore **850** intersects the fluid access passage **104** in the valve body **102**. The seal rings **802** are disposed in the seal recesses **812**. The seal rings **802** seal against the valve body **102** and the probe blocking member **122**. The seal rings **802** prevent process fluid in the process fluid passage **104** from exiting the valve body **102**. The seal rings **802** may be o-ring style seal rings. In the illustrated embodiment, the probe blocking member **122** does not function as a valve that completely prevents fluid from passing from the block valve **106** side of the probe blocking member to the probe port **118** side of the probe blocking member. As indicated above, the probe blocking device **110** can be changed to a shutoff valve configuration if sealing between the block valve side to the probe port side is required.

Referring to FIGS. **11**A and **11**B, the probe blocking member **122** is retained in the cylindrical bore **850** by the retention pin **804**. The retention pin **804** is secured in a retention pin bore **870** in the valve body **102** and extends into the annular retention recess **814** in the probe blocking member **122** (see FIG. **11**B). The retention pin **804** allows rotational movement of the blocking member **122** in the cylindrical bore **850** about an axis **880**. The retention pin **804** inhibits movement of the probe blocking member **122** in the cylindrical bore **850** in the direction of the axis **880**.

In the illustrated embodiment, the probe blocking device **110** is limited to ninety degrees of rotation between the probe accepting position (see FIGS. **7** and **8**) and the probe blocking position (see FIGS. **4**B and **4**C). This can be accomplished in a wide variety of different ways. In the illustrated embodiment, stop pins **302** are disposed in the valve body **102**. The stop pins **302** are positioned to engage the probe blocking device handle at the probe blocking position and at the probe accepting position.

The bleed valve **108** may take a wide variety of different forms. Examples of different types of valves that may be used include, but are not limited to, ball valves, plug valves, shuttle valves, needle valves, and the like. Any type of valve capable of opening and closing the bleed passage **150** can be used. The illustrated bleed valve **108** is substantially identical to the block valve, and therefore is not described again in detail.

In the illustrated embodiment, the bleed valve **108** is limited to ninety degrees of rotation between the closed position (see FIGS. **4**B and **4**C) and the open position (see FIGS. **10**A and **10**B). This can be accomplished in a wide variety of different ways. In the illustrated embodiment, stop pins **304** are disposed in the valve body **102**. The stop pins **304** are positioned to engage a bleed valve handle **700** at the open and closed positions.

The valve interlock arrangement **112** can take a wide variety of different forms. The valve interlock arrangement **112** may take any form that prevents the block valve **106** from being moved to the closed position when the probe blocking device **110** is in the probe accepting position. Additionally or alternatively, the valve interlock arrangement **112** may take any form that prevents the probe blocking device from being moved from the probe blocking position to the probe accepting position when the block valve **106** is closed. In one exemplary embodiment, the valve interlock arrangement **112** is configured to prevent an amount of movement of the block valve **106** from the open position toward the closed position from reaching an amount that would damage the probe **140**. In another exemplary embodiment, the valve interlock arrangement **112** is configured to prevent substantially all movement of the block valve **106** from the open position toward the closed position when the probe blocking device is in the probe accepting position. Additionally, as illustrated, the valve interlock **112** may be visible from the outside of the valve assembly. By making the interlock visible, a user will more readily recognize that the valve interlock **112** is working properly, rather than thinking there is a problem with the valve assembly.

In one embodiment, a valve interlock arrangement may include an access stop member coupled with an access blocking or probe blocking device, and a valve stop member coupled with a block valve or other such flow control valve. According to an aspect of the present application, the valve interlocking arrangement may be configured such that when the valve is in the open condition and the access blocking device is in the access palliating condition, the access stop member is positioned to impede movement of the valve (for example, by obstructing movement of the valve stop member) and thereby prevent the valve from being moved to the closed condition. In an exemplary embodiment, the access stop member includes a linkage coupled to the access blocking device, with a first link pivotally connected to a handle of the access blocking device and a second link pivotally connected to the first link and pivotally connected to the valve body. When the valve is in the open condition and the access blocking device is in the access permitting condition, the second link is positioned to obstruct movement of the valve stop member and thereby prevent the valve from being moved to the closed condition.

In the illustrated embodiment, the valve interlock arrangement **112** includes the probe blocking device **110**, a linkage **190** coupled to the probe blocking device **110**, and a block valve disk **192** coupled to the block valve **106**. In this embodiment, the block valve interface component **32** (see FIG. **1**A) is the block valve disk **192**, the probe interface component **30** (see FIG. **1**A) is the probe blocking device **110** and the linkage **190** links the two together. Referring to FIG. **4**B, the linkage **190** comprises a first link **194** pivotally connected to the handle **800** of the probe blocking device **110** at a first pivot point **196** and a second link **198** pivotally connected to the first link **194** at a second pivot point **200** and pivotally connected to the valve body **102** at a third pivot point **202**. Referring to FIG. **7**, the block valve disk **192** includes a recess **204** with a stop surface **206**. Referring to FIG. **4**B, when the probe blocking device **110** is in the probe blocking position, the second link **198** is spaced apart from the block valve disk **192**. Referring to FIG. **7**, when the block valve **106** is in the open position and the probe blocking device **110** is in the probe accepting position, the second link **198** is positioned in the recess **204** adjacent to the stop surface **206** to prevent the block valve **106** from being moved to the closed position.

According to another aspect of the present application, a valve interlocking arrangement may additionally or alternatively be configured such that when the valve is in the closed condition and the access blocking device is in the access blocking condition, the valve stop member is positioned to impede movement of the access blocking device (for example, by obstructing movement of the access stop member) and thereby prevent the access blocking device from being moved to the access permitting condition. Such an arrangement may be utilized to prevent insertion of a probe or other element through the access blocking device and against the closed valve (which could cause damage to the inserted element or to the valve). In an exemplary embodiment, the access stop member includes a linkage coupled to the access blocking device, with a first link pivotally connected to a handle of the access blocking device and a second link pivotally connected to the first link and pivotally connected to the valve body. When the valve is in the closed condition and the access blocking device is in the access blocking condition, the valve stop member is positioned to obstruct movement of the second link and thereby prevent the access blocking device from being moved to the access permitting condition.

FIG. **5** illustrates that when the block valve **106** of the illustrated assembly is closed, the recess **204** is not aligned with the second link **198**. When the probe blocking device **110** is moved from the probe blocking position toward the probe accepting position, the second link **198** engages the disk **192**. The engagement between the second link **198** and the disk **192** prevents the probe blocking device **110** from being moved to the probe accepting position when the block valve **106** is closed.

According to another aspect of the present application, in a valve assembly including a first valve (such as a block valve) and a second valve (such as a bleed valve), a valve interlock arrangement may additionally or alternatively be configured such that when the first valve is in the open condition, the second valve is prevented from being moved to the open condition. Still further, the valve interlock arrangement may additionally or alternatively be configured such that when the second valve is in the open condition, the first valve is prevented from being moved to the open condition.

As illustrated, when a bleed valve **108** is included, the valve interlock arrangement **112** may optionally be configured such that the bleed valve **108** is prevented from being opened when the block valve **106** is open (FIG. **6**A) and/or the block valve **106** is prevented from being opened when the bleed valve is open (FIG. **10**B). This can be accomplished in a wide variety of different ways. For example, any mechanical linkage, stop, etc. can be used to prevent one valve from being opened when the other valve is opened. In one such embodiment, a valve stop member is coupled to the block valve, and a bleed stop member is coupled to the bleed valve. When the block valve is open, the valve stop member is positioned to impede movement of the bleed valve (for example, by obstructing movement of the bleed stop member) and thereby prevent the bleed valve from being moved to the open condition. Additionally or alternatively, the valve interlocking arrangement may be configured such that when the bleed valve is open, the bleed stop member may be positioned to impede movement of the block valve (for example, by obstructing movement of the valve stop member) and thereby prevent the block valve from being moved to the open condition.

In the illustrated embodiment, the disk **192** and a disk **250** that is coupled to the bleed valve **108** are configured to prevent the bleed valve **108** from being opened when the block valve **106** is open and to prevent the block valve **106** from being opened when the bleed valve **108** is open. Referring to FIG. **4**B, the block valve disk **192** includes a recess **252** and the bleed valve disk **250** includes a recess **254**. (In the embodiment of FIG. **13**, where a bleed valve is not included, the recess need not be included in the block valve disk.) The recess **252** of the block valve disk **192** has a shape that is complimentary to the shape of the perimeter of the bleed valve disk **250**. The recess **254** of the bleed valve disk **250** has a shape that is complimentary to the shape of the perimeter of the block valve disk **192**.

Referring to FIG. 4B, the recesses **252**, **254** are adjacent to one another, such that when both the block valve **106** and the bleed valve **108** are in the closed position, either the block valve or the bleed valve (but not both) can be moved to the open position (see FIGS. **6**A and **10**A). Referring to FIG. **6**A, when the block valve **106** is in the open position, the perimeter of the block valve disk **192** is disposed in the recess **254** of the bleed valve **108**. As a result, the bleed valve **108** is prevented from being moved from the closed position to the open position. Referring to FIG. **10**A, when the bleed valve **108** is in the open position, the perimeter of the bleed valve disk **250** is disposed in the recess **252** disk **192**. As a result, the block valve **106** is prevented from being moved from the closed position to the open position.

FIGS. **4**A-**10**B illustrate operation of the process interface valve assembly **100**. FIGS. **4**A-**4**C illustrate the process interface valve assembly **100** with the block valve **106** closed, the bleed valve **108** closed, and the probe blocking device **110** in the probe blocking position. Referring to FIG. **4**C, the block valve **106** prevents fluid from flowing into the fluid access passage **104**, the bleed valve **108** prevents fluid from flowing out through the bleed port **152**, and the probe blocking device **110** prevents the probe from being inserted into contact with the valve element **120** of the block valve **106**.

Referring to FIG. **5**, the valve interlock arrangement **112** prevents the probe blocking device **110** from being moved to the probe accepting position when the block valve **106** is closed. This protects the block valve element **120** from being damaged by insertion of the probe **140** into contact with the block valve member when the block valve **106** is closed. In the illustrated embodiment, the second link **198** of the linkage **190** contacts the perimeter of the disk **192** to prevent the probe blocking device from being moved to the probe accepting position when the block valve **106** is closed.

FIGS. **6**A and **6**B illustrate the block valve **106** opened, with the bleed valve **108** closed, and the probe blocking device **110** in the probe blocking position. Referring to FIG. **6**B, the open block valve **106** now allows fluid to flow into the fluid access passage **104**. The probe fitting **166** prevents fluid from leaking around the probe **140**. The probe valve **143** (FIG. **4**A) may be closed to prevent any fluid that flows past the probe blocking device **110** from exiting the probe. The closed bleed valve **108** prevents fluid from flowing out through the bleed port **152**. The bleed valve **108** is prevented from being opened by the valve interlock assembly **112**. That is, the perimeter of the disk **192** is disposed in the recess **254** of the second disk **250** to prevent the bleed valve **108** from being opened. The probe blocking device **110** in the probe blocking position prevents the probe from being inserted into fluid access passage **104** and through the opened block valve **106**.

FIGS. **7** and **8** illustrate the probe blocking device **110** moved to the probe accepting position, with the block valve **106** opened, and the bleed valve **108** closed. Referring to FIG. **8**, the probe blocking member **122**, now in the probe accepting position, is open for insertion of the probe **140**. Referring to FIG. **7**, the block valve **106** is prevented from being closed by the valve interlock assembly **112**. That is, the second link **198** of the linkage **190** is disposed in the recess **204** of the disk **192** adjacent to the stop surface **206** to prevent the block valve **106** from being closed.

FIG. **8** illustrates the probe **140** inserted, with the probe blocking device **110** in the probe accepting position, the block valve **106** opened, and the bleed valve **108** closed. The probe valve **143** can be opened to sample fluid from the process fluid vessel **142** (FIG. **8**) or conduit through the probe **140**. The block valve **106** is prevented from being closed by the valve interlock assembly **112** to prevent the probe **140** from being damaged.

In one embodiment, an optional locking arrangement may be added to the probe blocking device **110** that would prevent the probe blocking device from being moved from the probe accepting position to the probe blocking position when the probe is inserted. The locking mechanism can take a wide variety of different forms. For example, any arrangement for locking the probe blocking device handle **800** to the block valve handle **180** or the valve body **102** can be used. FIGS. **14**A and **14**B illustrate one example of the wide variety of acceptable locking mechanisms. In the example, a locking mechanism **1400** comprises a spring loaded pin **1402**. The pin **1402** is mounted in a hole **1404** in an extension **1406** of the probe blocking device handle **800**. A spring **1407** biases the pin **1402** into a recess **1408** in the valve body **102** to lock the extension **1406** of the handle **800** to the valve body. The pin **1402** is pulled out of the recess **1408** against the biasing force of the spring **1407** (for example by pulling attached ring **1410**) to unlock the mechanism **1400**. When the mechanism **1400** is unlocked, the probe blocking device can be moved from the probe accepting position to the probe blocking position. As such, the valve operator is required to perform two steps (i.e. pull the pin and turn the handle) to move the probe blocking device **110** to the probe blocking position. This two step process reduces the likelihood that an operator will inadvertently move the probe blocking device **110** toward the probe blocking position while the probe **140** is in the probe blocking device.

FIGS. **9** and **9**A illustrate the probe blocking device **110** moved from the probe accepting position toward the probe blocking position, with the probe **140** inserted, the block valve **106** opened, and the bleed valve **108** closed, as in FIGS. **8**A-**8**B. Referring to FIGS. **9**B and **9**C, the first and second conical portions **822**, **824** contact the probe **140** over a large contact area to reduce the stress applied to the probe.

The probe **140** can be retracted out of the block valve **106** and out of the probe blocking device **110** when the components of the valve assembly **100** are in the positions illustrated by FIGS. **7** and **8**. Once the probe **140** is retracted out of the probe blocking device **110**, the probe blocking device **110** can be returned to the probe blocking position, as illustrated by FIGS. **4**A and **6**B. Once the probe blocking device **110** is in the probe blocking position, the block valve **106** can be closed, as illustrated by FIGS. **4**A-**4**C.

Referring to FIGS. **10**A and **10**B, after the block valve **106** is closed, the bleed valve can be opened to remove process fluid in the valve assembly **100**, in the probe **140**, and or in any instrumentation that is coupled to the probe. The block valve **106** is prevented from being opened by the valve interlock assembly. That is, the perimeter of the disk **250** is disposed in the recess **252** of the first disk **192** to prevent the block valve **106** from being opened. The probe blocking device **110** is in the probe blocking position to prevent the probe from being inserted into the fluid access passage **104** and into contact with the block valve **106**. After any process fluid is removed through the bleed valve **108**, the bleed valve can be closed to return the valve assembly to the condition illustrated by FIGS. **4**A-**4**C.

The valves **106**, **108**, and the probe blocking device **110** can be arranged in the valve body **102** in a wide variety of different positions. In the illustrated embodiment, the handles of the valves **106**, **108**, and the probe blocking device **110** are all on the same side of the valve body. This provides a visual indication of the state of both valves and the probe blocking device and makes operation of the valve assembly easy.

Still other features and components may be provided with one or more of the valve assemblies described herein. For example, the valve body **102** may be provided with threaded mounting holes and cap screws **803** or other such fasteners, to facilitate the assembly of mounting brackets, lockout brackets, heating elements, or other such components. As another example, the valve body may be provided with a port for installation of a sensor or gage, such as a thermometer, to monitor the condition of the fluid within the valve body **102**. This port may be blocked, for example, using a pipe plug **805**, when not in use.

The invention has been described with reference to the preferred embodiments. Modifications and alterations will occur to others upon a reading and understanding of this specification.

I claim:

1. A valve assembly comprising: a valve body having a process fluid access passage extending through the valve body from a process fluid port to an access port; a block valve disposed in the fluid access passage, said block valve being operable between open and closed conditions; and an access blocking device disposed in the process fluid access passage between the access port and the block valve, the access blocking device being moveable from an access blocking condition in which access to the block valve through the access port is blocked, to an access permitting condition in which access to the block valve through the access port is permitted;

wherein the access blocking device includes an internal passage comprising a central cylindrical bore and first and second notches intersecting bore edges at opposite ends of the internal passage, wherein the first and second notches provide an increased contact area between the access blocking device and a probe inserted through the central cylindrical bore.

2. The valve assembly of claim **1**, wherein the block valve is configured to allow a probe to be inserted through the process fluid port when the block valve is in the open condition.

3. The valve assembly of claim **1**, wherein the first and second notches each include cylindrical surfaces sized and oriented to correspond to an outer cylindrical surface of an inserted probe.

4. The valve assembly of claim **1**, wherein the first and second notches each include a first surface sized and oriented to correspond to an outer cylindrical surface of a first probe, and a second surface discontinuous with the first cylindrical surface and sized and oriented to correspond to an outer surface of a second probe, with the outer surface of the second probe being dimensionally different than the outer surface of the first probe.

5. The valve assembly of claim **1**, further comprising a bleed passage defined in the valve body and extending from a bleed port to the fluid access passage, and a bleed valve disposed in the bleed passage between the bleed port and the fluid access passage, the bleed valve being operable between an open condition and a closed condition.

6. The valve assembly of claim **1**, further comprising a valve interlock arrangement configured such that operability of one of the block valve and the probe blocking device is a function of an operational state of the other of the block valve and the probe blocking device.

7. The valve assembly of claim **6**, wherein the block valve is prevented from being moved to the closed condition when the access blocking device is in the access permitting condition.

8. The valve assembly of claim **6**, wherein the access blocking device is prevented from being moved to the access permitting condition when the block valve is in the closed condition.

9. A valve assembly comprising:

a valve body having a process fluid access passage extending through the valve body from a process fluid port to an access port;

a block valve disposed in the fluid access passage, said block valve being operable between open and closed conditions; and

an access blocking device disposed in the process fluid access passage between the access port and the block valve, the access blocking device being moveable from an access blocking condition in which access to the block valve through the access port is blocked, to an access permitting condition in which access to the block valve through the access port is permitted; and

a valve interlock arrangement configured such that operability of one of the block valve and the probe blocking device is a function of an operational state of the other of the block valve and the probe blocking device;

wherein the valve interlock arrangement comprises an access stop member coupled to the access blocking device and a valve stop member coupled to the block valve, wherein when the block valve is in the open condition and the access blocking device is in the access permitting condition, the access stop member is positioned to engage the valve stop member and thereby prevent the block valve from being moved to the closed condition; and

wherein the access stop member comprises a linkage coupled to the access blocking device, with a first link connected to and pivotable with respect to a handle of the access blocking device and a second link having a first portion connected to and pivotable with respect to the first link and a second portion connected to and pivotable with respect to the valve body, wherein when the block valve is in the open condition and the access blocking device is in the access permitting condition, the second link is positioned to engage the valve stop member and thereby prevent the block valve from being moved to the closed condition.

10. The valve assembly of claim **9**, wherein the access blocking device includes an internal passage comprising a central cylindrical bore and first and second notches at opposite ends of the internal passage.

11. The valve assembly of claim **10**, wherein the first and second notches provide an increased contact area between the access blocking device and a probe inserted through the central cylindrical bore to reduce said stress applied to the probe when the access blocking device is moved from the access permitting position toward the access blocking position and into contact with the probe.

12. The valve assembly of claim **9**, wherein the valve stop member comprises a plate connected to a handle of the block valve for rotation therewith.

13. The valve assembly of claim **9**, wherein when the block valve is in the closed condition and the access blocking device is in the access blocking condition, the valve stop member is positioned to block movement of the second link and thereby prevent the access blocking device from being moved to the access permitting condition.

14. The valve assembly of claim **9**, wherein the block valve is configured to allow a probe to be inserted through the process fluid port when the block valve is in the open condition.

15. The valve assembly of claim **9**, further comprising a bleed passage defined in the valve body and extending from a bleed port to the fluid access passage, and a bleed valve disposed in the bleed passage between the bleed port and the fluid access passage, the bleed valve being operable between an open condition and a closed condition.

16. A valve assembly comprising:

a valve body having a process fluid access passage extending through the valve body from a process fluid port to an access port and a bleed passage defined in the valve body and extending from a bleed port to the fluid access passage;

a block valve disposed in the fluid access passage, said block valve being operable between open and closed conditions;

a bleed valve disposed in the bleed passage between the bleed port and the fluid access passage, the bleed valve being operable between an open condition and a closed condition;

an access blocking device disposed in the process fluid access passage between the access port and the block valve, the access blocking device being moveable from an access blocking condition in which access to the block valve through the access port is blocked, to an access permitting condition in which access to the block valve through the access port is permitted; and

a valve interlock arrangement configured such that operability of one of the block valve and the probe blocking device is a function of an operational state of the other of the block valve and the probe blocking device;

wherein the valve interlock arrangement is further configured such that the bleed valve is prevented from being opened when the block valve is in the open condition, and the block valve is prevented from being opened when the bleed valve is in the open condition.

17. The valve assembly of claim **16**, wherein the block valve is prevented from being moved to the closed condition when the access blocking device is in the access permitting condition.

18. The valve assembly of claim **16**, wherein the access blocking device is prevented from being moved to the access permitting condition when the block valve is in the closed condition.

19. The valve assembly of claim **16**, wherein the valve interlock arrangement comprises an access stop member coupled to the access blocking device and a valve stop member coupled to the block valve, wherein when the block valve is in the open condition and the access blocking device is in the access permitting condition, the access stop member is positioned to engage the valve stop member and thereby prevent the block valve from being moved to the closed condition.

20. The valve assembly of claim **16**, wherein the valve interlock arrangement comprises a valve stop member coupled to the block valve, and a bleed stop member coupled to the bleed valve, wherein when the block valve is open, the valve stop member is positioned to engage the bleed stop member and thereby prevent the bleed valve from being moved to the open condition.

21. The valve assembly of claim **16**, wherein the valve interlock arrangement comprises a valve stop member coupled to the block valve, and a bleed stop member coupled to the bleed valve, wherein when the bleed valve is open, the bleed stop member is positioned to engage the valve stop member and thereby prevent the block valve from being moved to the open condition.

22. The valve assembly of claim **16**, wherein the valve stop member comprises a plate connected to a handle of the block valve for rotation therewith.

23. The valve assembly of claim **16**, wherein the bleed stop member comprises a plate connected to a handle of the block valve for rotation therewith.

* * * * *